INSTALLATION AND OPERATION MANUAL

MPW-1

TDM Pseudowire Access Gateway

MP-4100 Version 2.0

RAD
data communications
The Access Company

MPW-1

TDM Pseudowire Access Gateway

MP-4100 Version 2.0

Installation and Operation Manual

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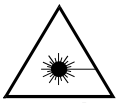
Quick Start Guide

If you are familiar with the MPW-1 modules, use this guide to prepare it for operation.



Warning

SFPs installed on MPW-1 modules may be equipped with a laser diode. In such cases, a label with the laser class and other warnings as applicable will be attached near the optical transmitter. The laser warning symbol may be also attached.

For your safety:

- **Before turning on the equipment, make sure that the fiber optic cable is intact and is connected to the optical transmitter.**
- **Do not use broken or unterminated fiber-optic cables/connectors.**
- **Do not look straight at the laser beam, and do not look directly into the optical connectors while the module is operating.**
- **Do not attempt to adjust the laser drive current.**
- **The use of optical instruments with this product will increase eye hazard. Laser power up to 1 mW could be collected by an optical instrument.**
- **Use of controls or adjustment or performing procedures other than those specified herein may result in hazardous radiation exposure.**

ATTENTION: The laser beam may be invisible!

Preparations for Operation

1. If necessary, install the prescribed SFPs in the MPW-1 SFP sockets.
2. Insert the module in the assigned I/O slot.
3. Refer to the site installation plan, identify the cables intended for connection to the MPW-1 connectors, and connect the cables as explained below.

Connecting Cables to Ethernet Ports

➤ **To connect cables to the optical Ethernet ports:**

1. Connect each prescribed cable to the corresponding MPW-1 connector, ETH1, ETH2 or ETH3. When two fibers are used, pay attention to connector polarity: the transmitter output is at left-hand side.

Connecting Cables to Electrical Ethernet Ports

➤ **To connect cables to the MPW-1 electrical Ethernet ports:**

1. Connect the prescribed cable to the corresponding connector, ETH1, ETH2, or ETH3.

Configuring Physical Layer Parameters

Configuring Internal DS1 Ports Physical Layer Parameters

For the supervision terminal, use the **Configuration > Physical Layer > I/O** screen.

Parameter	Values	Parameter	Values
Port Number	**1** to 8	Wait to Restore	0 to 999 seconds
Administrative Status	**DOWN** UP	Cross Connect	**DS0** (framed modes only) DS1
Name	Up to 32 alphanumeric characters	Destination Slot (DS1 cross-connect mode only)	CL IO-1 to IO-10
Redundancy	**NONE** DUAL CABLE P.TX	Destination Port (DS1 cross-connect mode only)	E1 or T1 external or internal ports: **1** to 8 DS1 ports: **1** to 8 STM-1 PDH ports: **1** to 63 for OC-3 PDH ports: **1** to 84
Primary (when Redundancy is DUAL CABLE P.TX)	**YES** NO	Framing	**FRAMED** UNFRAMED
Redundant Slot (when Redundancy is DUAL CABLE P.TX)	CL I/O-1 to I/O-10	Signaling	**NO** YES
Redundant Port (when Redundancy is DUAL CABLE P.TX)	E1 or T1 external or internal ports: **1** to 8 DS1 ports: **1** to 8 STM-1 PDH ports: **1** to 63 for OC-3 PDH ports: **1** to 84		

Configuring Internal DS1 Port Timeslot Utilization

For framed internal DS1 ports using the DS0 cross-connect mode, configure timeslot assignment (including timeslots using split assignment).

For the supervision terminal, use the last item, **Time Slot Assignment**, on the **Configuration > Physical Layer > I/O** screen of the desired MPW-1 internal DS1 port, or use the **Configuration > System > TS Assignment** screen in accordance with the information appearing in the *Megaplex-4100 Installation and Operation Manual*.

Configuring Ethernet Ports Physical Layer Parameters

For the supervision terminal, use the **Configuration > Physical Layer > I/O** screen.

Parameter	Values	Parameter	Values
Port Number	**1** to 3 All Ports	Auto Negotiation	**ENABLE** DISABLE
Administrative Status	**DOWN** UP	Max. Capability Advertised (autonegotiation enabled)	10Mbps half duplex 10Mbps full duplex 100Mbps half duplex **100Mbps full duplex**
Name	Up to 32 alphanumeric characters	Speed & Duplex (autonegotiation disabled)	10Mbps half duplex 10Mbps full duplex 100Mbps half duplex **100Mbps full duplex**

Configuring the General Router Parameters

For the supervision terminal, use the **Configuration > Applications >** Router > Interface screen.

Parameter	Values
Default Gateway	Valid IP address in the subnet of one of the router interfaces, in dotted-quad notation
ARP Aging Time	300 to 1000000 sec

Configuring the Router Interfaces

For the supervision terminal, use the **Configuration > Applications > Router** screen.

Parameter	Values	Parameter	Values
Number	**1** to 100	Slot	I/O-1 to I/O-10 CL-A and CL-B
Name	Up to 32 alphanumeric characters	Port	I/O modules with Ethernet ports: ETH port (ETH-1, ETH-2 or ETH-3) CL.1/GbE modules: GbE-1 and GbE-2 CL.1/155GbE modules: GbE-1, GbE-2, and VCG1 to VCG8
IP address	Valid IP address in dotted-quad notation	VLAN Tagging	**DISABLE** ENABLE
IP Mask	Valid IP subnet mask in dotted-quad notation	VLAN ID	**1** to 4094

Configuring Static Routes

For the supervision terminal, use the **Configuration > Applications > Router > Static Route** screen.

Parameter	Values
Number	**1** to 100
IP Address	Valid IP address in dotted-quad notation
IP Mask	Valid IP subnet mask in dotted-quad notation
Next Hop	Valid next hop IP address in dotted-quad notation

Configuring the Pseudowire Peers

For the supervision terminal, use the **Configuration > Applications > Router > Peers** screen.

Parameter	Values
Peer Number	**1** to 100
Name	Up to 32 alphanumeric characters
Peer IP Address	Valid IP address in dotted-quad notation
Peer Next Hop Address	Valid next hop IP address in dotted-quad notation

Configuring General Pseudowire Parameters

For the supervision terminal, use the **Configuration > Applications > Multi-Service over PSN > PW > General Parameters** screen.

Parameter	Values	Parameter	Values
PW Type	**TDMoIP CE** HDLC CESoPSN SAToP	OAM Mode	**PROPRIETARY** DISABLE
PSN Type	**UDP/IP** MPLS/ETH	Out PW Label	UDP/IP: **1** to 8063 MPLS/ETH: **16** to 1048575
Peer Number	**1** to 100	In PW Label	UDP/IP: **1** to 8063 MPLS/ETH: **16** to 1048575

Configuring Pseudowire PSN Parameters

For the supervision terminal, use the **Configuration > Applications > Multi-Service over PSN > PW > PSN Parameters** screen.

Parameter	Values	Parameter	Values
ToS (when PSN Type is UDP/IP)	0 to 255	Egress Tunnel Label (when PSN Type is MPLS and Egress Tunnel Tagging is ENABLE)	16 to 1048575
Ingress Tunnel Tagging (when PSN Type is MPLS)	**DISABLE** ENABLE	EXP Bits (when PSN Type is MPLS)	**0** to 7
Ingress Tunnel Label (when PSN Type is MPLS MPLS and Ingress Tunnel Tagging is **ENABLE**)	16 to 1048575	VLAN Priority (when VLAN tagging is enabled)	**0** to 7
Egress Tunnel Tagging (when PSN Type is MPLS)	**DISABLE** ENABLE	Payload Format (only for TDMoIP CE)	**V2** V1

Configuring Pseudowire Service Parameters

For the supervision terminal, use the **Configuration > Applications > Multi-Service over PSN > PW > Service Parameters** screen.

Parameter	Values	Parameter	Values
TDM Bytes in Frame	Multiplier range: **1** to 30 (1 × 48 bytes to 30 × 48 bytes)	Sensitivity (not used for HDLCoPSN)	**DATA** DELAY
Payload Size	4 to 1440 bytes	Voice OOS (not used for HDLCoPSN and SAToP)	**00** to FF
Jitter Buffer (not used for HDLCoPSN)	Framed: **2500** to 200000 µsec Unframed: 500 to 200000 µsec (default: **2500**µsec)	Data OOS (not used for HDLCoPSN and SAToP)	**00** to FF (hexa)
Far End Type	**E1** T1 ESF T1 SF UNFRAMED	OOS Signaling (not used for HDLCoPSN; displayed only when the attached internal DS1 port is configured with Signaling = YES)	**FORCED IDLE** FORCED BUSY

Configuring Attachment Circuit Parameters

For the supervision terminal, use the **Configuration > Applications > Multi-Service over PSN > PW > Service Parameters > Attachment Circuit** screen.

Parameter	Values
Slot	**IO-1** to IO-10
Int DS1 Number	**1** to 8
Time Slots	See below

Selecting Timeslots Connected to a Pseudowire

For each pseudowire connected to an internal DS1 port using the DS0 cross-connect mode, configure timeslot assignment.

For the supervision terminal, use the **Configuration > Applications > Multi-Service over PSN > PW > Service Parameters > Time Slots** screen.

Configuring Pseudowires as System Timing References

1. For the supervision terminal, use the **Configuration > System > Clock Source > Recovered** screen to specify the pseudowire that can be used as system timing references.

Parameter	Values	Parameter	Values
Slot	**I/O-1** to I/O-10	Administrative Status	**DOWN** UP
Type	**ADAPTIVE**	Source Quality	STRATUM 1 (not supported) STRATUM 2 (not supported) STRATUM 3 STRATUM 3E **STRATUM 4**
ID	**1** to 20	Network Type	**Type B** Type A
PW Number	1 to 640		

2. Use the **Configuration > System > Clock Source** screen to include the required pseudowires as timing reference sources, in accordance with the information appearing in the *Megaplex-4100 Installation and Operation Manual*.

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Chapter 1
Introduction

1.1 Overview

This manual describes the technical characteristics, applications, installation and operation of the MPW-1 pseudowire access gateway I/O module for the Megaplex-4100 Next Generation Multiservice Access Node.

MPW-1 operates as a pseudowire server for TDM traffic (E1, T1, SHDSL, ISDN, high-speed and low-speed data, voice) received via the internal Megaplex-4100 TDM buses from other I/O modules installed in the same chassis. MPW-1 performs the following tasks:

- Interfacing to the Megaplex-4100 internal TDM buses (equivalent capacity of 256 timeslots, or eight 2.048 Mbps streams).
- Conversion between TDM and pseudowire packet formats. The conversion parameters are controlled by defining pseudowires (see *Megaplex-4100 Installation and Operation Manual* for details), and can be optimized for the specific end-user's equipment and the application requirements.
- Forwarding the pseudowire packet streams, either directly to a PSN (through the MPW-1 external Fast Ethernet ports, or via its internal Fast Ethernet ports), for forwarding over any bridge port within the Megaplex-4100 (refer to the *Megaplex-4100 Installation and Operation Manual* for details). Each pseudowire can be forwarded to the desired endpoint through the packet-switched network. Both UDP/IP and MPLS/ETH networks are supported. The user can also specify forwarding and priority/quality of service parameters.

Installing a MPW-1 module enhances Megaplex-4100 capabilities and services by enabling the transport of legacy TDM traffic from other modules over Ethernet, IP, and MPLS packet-switched networks (PSNs), even when the Megaplex-4100 is not equipped with CL modules with GbE ports. MPW-1 supports the TDMoIP, CESoPSN, SAToP and HDLCoPSN pseudowire protocols.

For details regarding the integration of MPW-1 modules in Megaplex-4100 systems and systems applications, refer to the *Megaplex-4100 Installation and Operation Manual*.

Product Options

MPW-1 is a pseudowire access gateway module with two types of ports:

- Internal TDM (DS1) ports, for TDM traffic from the internal TDM buses of the Megaplex-4100
- Internal and external Fast Ethernet ports, for the packetized data streams.

MPW-1 is offered in two models with similar characteristics, which differ only in the type of interfaces supported by the external Fast Ethernet ports:

- MPW-1/UTP: has three 10/100BASE-TX interfaces terminated in RJ-45 connectors
- MPW-1/SFP: has three sockets for Fast Ethernet SFP optical transceivers. RAD offers several types of SFPs capable of meeting a wide range of operational requirements.

Applications

MPW-1 can provide transport services even in a Megaplex-4100 without GbE ports (that is, Megaplex-4100 equipped with CL.1 or CL.1/155 modules). A typical application of this type is shown in *Figure 1-1*. In this application, the legacy traffic from TDM I/O modules intended for transport over the PSN is connected to the MPW-1 internal DS1 ports, using the desired cross-connect mode (DS0 or DS1). The traffic is then packetized to create data streams in accordance with the desired pseudowire protocols (TDMoIP, CESoPSN, SAToP, or HDLCoPSN), independently selectable for each pseudowire. The resulting data streams are sent via the external Fast Ethernet ports of the module, for routing to the desired destinations, where each stream is converted back to the original TDM stream.

Figure 1-1. Basic MPW-1 Application (Megaplex-4100 without GbE Ports)

When the Megaplex-4100 has CL modules with GbE ports, for example, CL.1/GbE or CL.1/155GbE, packetized traffic can also be sent via any bridge port on any module installed in the chassis (see description of available bridge ports and Ethernet services in the *Megaplex-4100 Installation and Operation Manual*). *Figure 1-2* shows a typical application for a Megaplex-4100 equipped with CL.1/GbE modules. In this application, pseudowires are routed to the PSN through the GbE ports located on the CL.1/GbE module (this capability is in addition to the local Fast Ethernet ports).

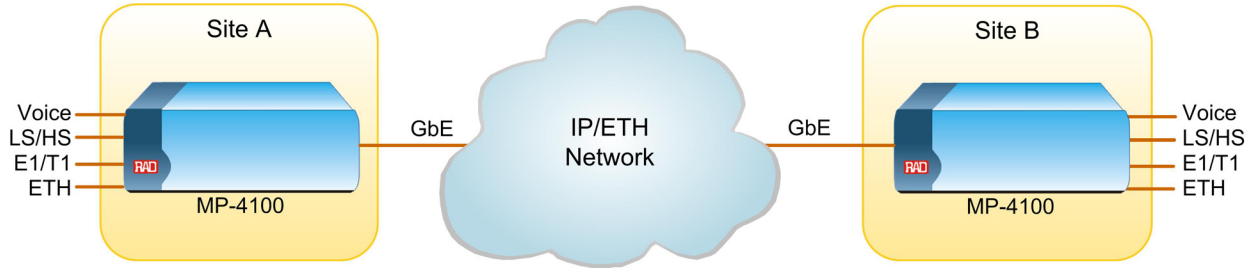


Figure 1-2. Basic MPW-1 Application (Megaplex-4100 with GbE Ports)

The application of *Figure 1-2* also permits users connected to MPW-1 Ethernet ports access to packet switched networks (PSN), for example, Internet or metropolitan Ethernet networks, via the Megaplex-4100GbE links.

Another application for a Megaplex-4100 equipped with CL.1/GbE modules is shown in *Figure 1-3*. In the application shown in *Figure 1-3*, Megaplex-4100 located at Site B does not have without direct access to the PSN: therefore, pseudowire traffic generated by MPW-1 modules at site B is directed, by internal flows within the Megaplex-4100, to ASMi-54C SHDSL.bis I/O modules, which transport the traffic over SHDSL.bis lines to a DSLAM located at the point-of-presence (PoP). The PSN provides the connection to the GbE ports of the Megaplex-4100 at Site A, where MPW-1 modules convert the packetized traffic back to legacy TDM traffic.

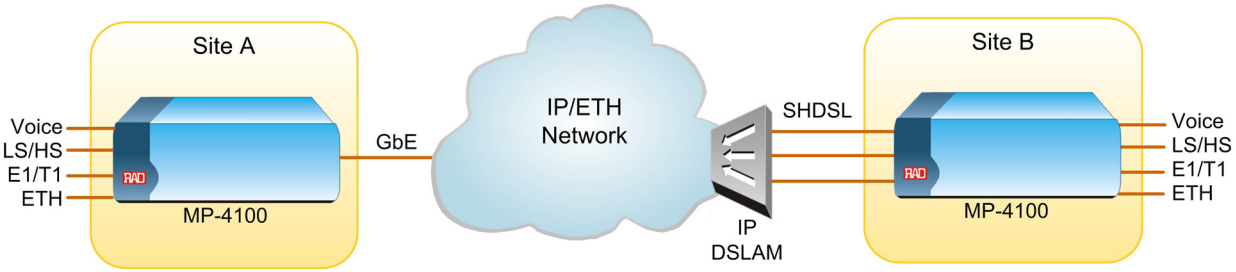


Figure 1-3. MPW-1 Application Using Ethernet over DSL

The applications shown in *Figure 1-2* and *Figure 1-3* can also be implemented in Megaplex-4100 with CL.1/155GbE modules. However, CL.1/155GbE modules support additional capabilities: for example, E1 or T1 traffic received via STM-1/OC-3 links can be directed to the MPW-1 modules for processing and transport over PSN.

Another option, illustrated at Site A in *Figure 1-4*, is applicable for Megaplex-4100 connected to STM-1/OC-3 infrastructure, but not to the PSN infrastructure: TDM services are converted to packet traffic at Site A and transferred over SDH/SONET using virtual concatenation. The desired bandwidth is specified by configuring a virtually concatenated group (VCG) using the appropriate type and number of VCs/VTs, and availability can be enhanced by configuring LCAS. At the desired location in the SDH/SONET network, the virtually concatenated group is terminated by a RAD Interface Converter, RICi-155GE, and converted to Ethernet for transmission over the PSN to Site B, where another Megaplex-4100 with MPW-1 converts the packetized traffic back to legacy TDM traffic.

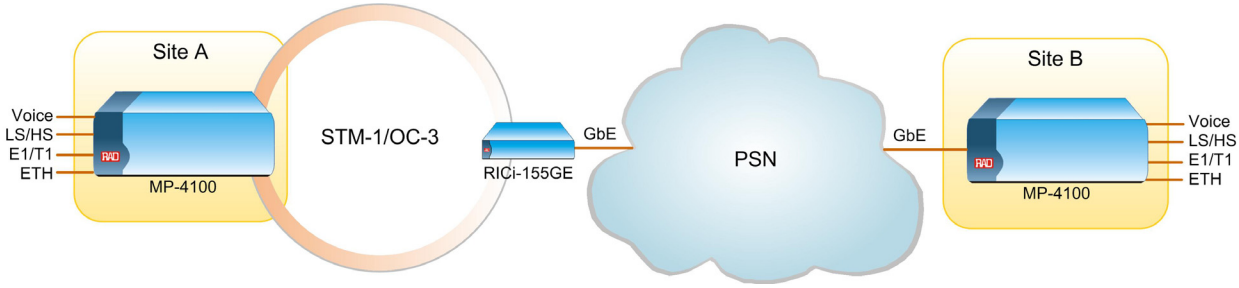


Figure 1-4. MPW-1 Application – Legacy and Ethernet Services over SDH/SONET and Packet Switched Networks

Features

MPW-1 is a pseudowire server I/O module that provides TDM pseudowire access gateway services over packet-switched networks (Ethernet, IP, and MPLS) for TDM traffic (E1, T1, SHDSL, ISDN, high-speed and low-speed data, voice) received via the Megaplex-4100 TDM buses from other modules. The MPW-1 module has eight independently-configurable internal DS1 ports, each capable of handling 32 timeslots, for a total processing capacity of 256 timeslots (the equivalent of 8 E1, or 2.048 Mbps, streams). Multiple MPW-1 modules can be installed in the Megaplex-4100 chassis, in accordance with the required pseudowire transport capacity.

The MPW-1 module provides pseudowire emulation services over packet-switched networks using the following user-configurable protocols:

- TDMoIP (TDM over IP) in accordance with RFC5087, and TDMoMPLS in accordance with RFC5087 and ITU-T Rec. Y.1413
- HDLCoPSN (HDLC over PSN) in accordance with RFC5087 and RFC4618 (except Clause 5.3 – PPP)
- CESoPSN (structure-aware TDM circuit emulation over PSN) in accordance with RFC5086
- SAToPSN (structure-agnostic TDM over PSN) in accordance with RFC4553

MPW-1 meets the requirements for edge-to-edge simulation of TDM circuits over PSN in accordance with RFC4197, including high-performance adaptive timing recovery capabilities. Pseudowires of all types, except HDLCoPSN, can be selected as timing sources for the Megaplex-4100 nodal timing subsystem.

The number of pseudowires supported by each MPW-1 internal DS1 port depends on the payload framing mode:

- Each framed internal DS1 port can be served by up to 16 pseudowires, where each pseudowire can be separately routed to its desired destination over the PSN, for a total of 128 destinations per module. The total number of pseudowires is up to 640 per Megaplex-4100 chassis.

  The actual number of active pseudowires depends on internal DS1 port timeslot assignment (a timeslot can be included in a single pseudowire). An internal cross-connect matrix, similar in capabilities to the cross-connect matrices in other I/O modules, provides full control over timeslot routing from any TDM port within the Megaplex-4100 to the desired pseudowire, independently for each port, using either DS0 or DS1 cross-connect mode.
- An unframed E1 or T1 port is served by a single pseudowire (in this case, only the DS1 cross-connect mode can be used).

Each pseudowire terminated on the MPW-1 can be independently configured to handle the desired type of traffic:

- Transparent transfer of data (unframed E1 streams) using TDMoPSN, or SAToPSN
- Transfer of framed E1 and T1 streams, using TDMoPSN and CESoPSN.

  To support voice payload, the signaling information can also be transported. Note that when using CESoPSN, any timeslots carrying signaling information (either channel-associated signaling (CAS), or common-channel signaling

(CCS) such as Signaling Scheme 7 (SS7), ISDN PRI signaling, etc.) can be transparently transferred within the pseudowire, as regular data timeslots.

- Fractional E1 and T1 services, with or without CAS, are supported by means of TDMoPSN. Without CAS, CESoPSN can also be used.
- HDLC traffic can be carried over framed and unframed E1 and T1 using HDLCoPSN. This enables efficient and transparent transfer of Frame Relay traffic.

Packet structure is independently selectable for each pseudowire, for compatibility with the various pseudowire protocols (TDMoPSN, CESoPSN, HDLCoPSN, SAToPSN) and the PSN type (UDP/IP or MPLS/ETH). For maximum flexibility in system applications, the framing format of the pseudowire device at the destination (referred to as a ***pseudowire peer***) can also be taken into account, thus in many cases traffic using the E1 standards can be directed at destinations using the T1 standards, and vice versa.

The pseudowire exit port toward the PSN is also selectable: either via one of the MPW-1 Ethernet ports, or, when Megaplex-4100 is equipped with GbE ports, via any other bridge port (GbE, Fast Ethernet, or VCG) of any module installed in the chassis. The selectable exit ports are configured as router interfaces, where each router interface has its own IP source address, and optionally – its own VLAN (each MPW-1 module supports up 6 interfaces, for a maximum of 100 router interfaces per Megaplex-4100). The user can also specify static routes to control the IP routing.

The internal MPW-1 Ethernet subsystem is based on an Ethernet switch with built-in flow classification engine, and support for VLAN tagging according to IEEE 802.1Q and 802.1p. The Ethernet switch switches traffic among the module Ethernet ports and the pseudowire engine, and, when a CL module with GbE ports is installed in the Megaplex-4100 – also to the Ethernet traffic subsystem of the CL module (for connection via any other bridge port in the Megaplex-4100, via the CL GbE ports to a packet-switched network, or for transmission through the SDH/SONET network via virtually concatenated groups). The internal Ethernet switch also enables connecting MPW-1 Ethernet ports to the Megaplex-4100 management flow.

MPW-1 supports the OAM mechanism for connectivity verification, and pseudowire configuration mismatch prevention. MPW-1 also supports a wide range of performance monitoring statistics to enable analyzing transmission problems and optimizing PSN transmission performance.

To enable optimal handling of pseudowire traffic within the PSN, the following parameters can be configured:

- For Ethernet transport networks: outgoing pseudowire packets are assigned to a dedicated VLAN ID according to 802.1Q and marked for priority using 802.1p bits.
- For IP transport networks: outgoing pseudowire packets are marked for priority using DSCP, ToS, or Diffserv bits. This allows TDMoIP packets to be given the highest priority in IP networks.
- For MPLS transport networks: outgoing pseudowire packets are assigned to a specific MPLS tunnel, and marked for priority using the EXP bits.

The proper balance between the PSN throughput and delay is achieved via configurable packet size. A jitter buffer with selectable size compensates for packet delay variation (jitter) of up to 200 msec in the network.

On the TDM side, MPW-1 timing is locked to the Megaplex-4100 nodal timing, because its traffic is synchronously collected from Megaplex-4100 TDM buses, and the received traffic is also deposited on these buses. Each pseudowire has its own adaptive timing recovery mechanism, in accordance with the options listed in RFC4197. The recovered pseudowire clocks can be used as timing reference signals for the nodal Megaplex-4100 timing subsystem, and therefore MPW-1 allows flexible timing distribution.

The MPW-1 module supports 1:1 redundancy protection between internal DS1 ports, and between an internal DS1 port and a user-selected legacy TDM port (E1, T1, SHDSL, PDH, etc.) with redundancy. To minimize traffic when a pseudowire it is not active due to the redundancy mechanism, the pseudowire transmits only OAM packets to ensure connectivity.

The MPW-1 module operating parameters are determined by commands received from the Megaplex-4100 CL module. The CL module can also download new software to the module, when the Megaplex-4100 software is updated.

The module supports comprehensive diagnostics, including power-up self-test, and local and remote loopbacks for each port. Front-panel indicators indicate at a glance the status of Ethernet module ports.

1.2 Physical Description

The MPW-1 module occupies one I/O slot in the Megaplex-4100 chassis. Typical panels are shown in *Figure 1-5*.

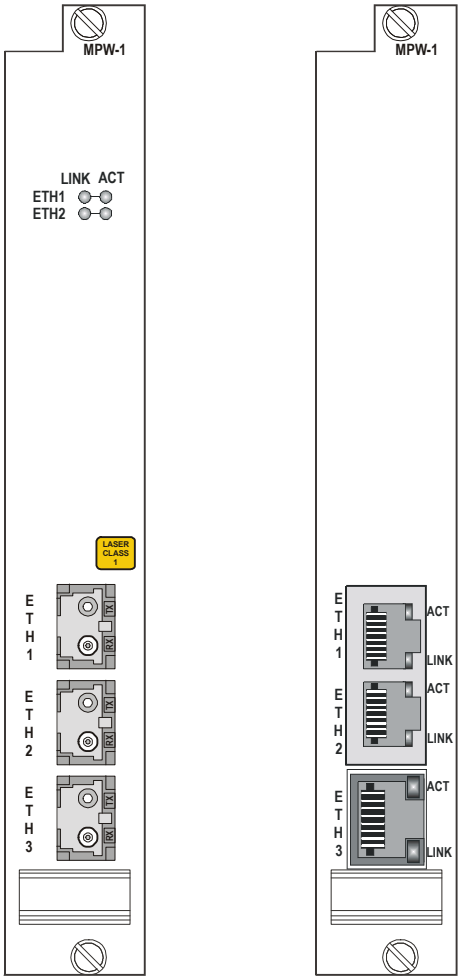


Figure 1-5. Typical Module Panels

Module with Ethernet Ports Equipped with SFPs

Module with Copper Ethernet Ports

The MPW-1 panel includes three Ethernet ports, designated ETH1, ETH2 and ETH3. The ports are equipped either with SFPs, or terminated in RJ-45 connectors.

Each port has its own set of ACT and LINK status indicators, except for the ETH3 port, when equipped with SFP.

The functions of the ETH port status indicator are as follows:

- ACT (yellow): flashes in accordance with the transmit and/or receive activity on the corresponding port
- LINK (green): lights when the link integrity signal is detected by the corresponding port (normal operating condition).

1.3 Functional Description

Figure 1-6 shows the functional block diagram of the MPW-1 module.

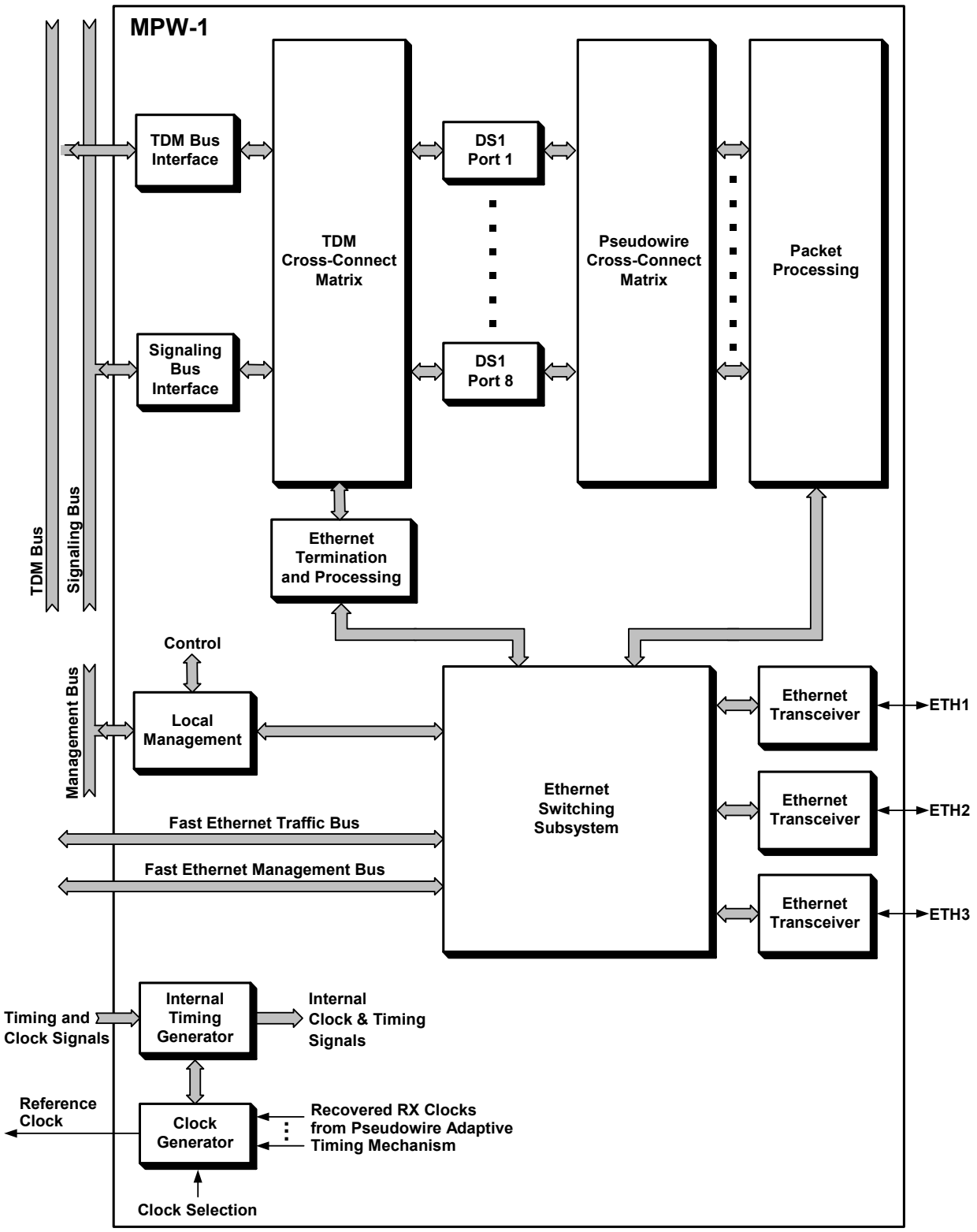


Figure 1-6. MPW-1 Functional Block Diagram

The MPW-1 module includes the following main subsystems:

- TDM subsystem, including:
  - Signaling and TDM bus interfaces
  - TDM cross-connect matrix
  - Internal DS1 ports
- Pseudowire processing subsystem, including:
  - Pseudowire cross-connect matrix
  - Packet processors
- Ethernet subsystem, including:
  - Layer 2 Ethernet switching subsystem
  - Ethernet port interfaces (transceivers)
  - Ethernet termination and processing
- Timing subsystem, including:
  - Pseudowire recovered clock generator
  - Internal clock timing generator
- Local management subsystem.

TDM Subsystem

TDM and Signaling Bus Interfaces

The function of these bus interfaces is to connect the MPW-1 module to the TDM and signaling buses of the Megaplex-4100 chassis.

The TDM bus interfaces are used to transfer payload destined to the internal DS1 ports located on the MPW-1 module. The payload is transferred from the Megaplex-4100 buses to the bus side of the cross-connect (routing) matrix of the module, in accordance with the commands received from the CL module.

Pseudowires can also be transfer signaling information (this is necessary to support voice traffic).

TDM Cross-Connect Matrix

The MPW-1 module includes a TDM cross-connect matrix that controls the routing of payload within the module, that is, between the TDM and signaling interfaces and the internal DS1 ports, under the control of the CL module.

Actually, it is the way the TDM cross-connect matrix performs cross-connect operations that creates the internal DS1 ports. The user can select between two cross-connect modes, separately for each internal DS1 port:

- DS0 cross-connect mode – used when it is necessary to control the routing of individual timeslots, and therefore it is relevant only when the internal DS1 port uses the framed mode.
- DS1 cross-connect mode – used when the traffic of the internal DS1 port is handled as a whole. This means that when the port uses the unframed mode,

all of the 32 timeslots of the port are handled as a single data stream and are transparently connected to another user-selected port. In the framed mode, only the payload timeslots are transparently connected (31 timeslots when connecting to another E1 port, 24 for connecting to a T1 port).

The CL module takes care of all the tasks necessary to enable the MPW-1 TDM cross-connect matrix to perform the desired services in accordance with the cross-connect mode selected for each port, in a way similar to the functions performed by the cross-connect matrix of each I/O module. Therefore, all the routing functions are actually performed on the CL module: the MPW-1 matrix only handles the transfer of payload between the chassis bus side and the internal DS1 ports of the module, in accordance with the instructions received from the CL module.

The result is that when using the DS0 cross-connect mode, the following services are available for the traffic flowing through the module ports:

- Services related to TDM traffic:
  - Connection of timeslots from I/O or PDH ports of other modules installed in the Megaplex-4100 to the desired MPW-1 internal DS1 port. When signaling support is enabled for the corresponding DS1 port, the matrix also routes the signaling information associated with each voice timeslot in parallel with the timeslot data.
  - Bypassing timeslots among the MPW-1 internal DS1 ports, or among ports (channels) located on other modules and the internal DS1 ports located on the MPW-1 module.
  - Unidirectional routing of timeslots, and broadcasting from one timeslot to multiple destinations.

  In addition to payload routing, the TDM cross-connect matrix is also used to activate local and remote loopbacks on selected timeslots of the MPW-1 internal DS1 ports.
- Connection of management traffic, to enable inband management via a selected timeslot.

As mentioned above, when using the DS1 cross-connect mode, the whole group of timeslots intended for the corresponding DS1 port is handled as a single stream. Thus, the source port must also use the DS1 cross-connect mode and the same framing mode.

Internal DS1 Ports

The internal DS1 ports are logical ports that provide the linkage between the packet processing subsystem and the TDM subsystem:

- On the TDM side, a DS1 port serves as an endpoint for traffic from the TDM and signaling buses. Each I/O or PDH port in the Megaplex-4100 that will use pseudowires on MPW-1 must be assigned bandwidth (timeslots) on the internal DS1 port, using the standard Megaplex-4100 timeslot assignment procedures.
- On the pseudowire side, a DS1 port serves as the collection point for timeslots to be carried by each pseudowire. Thus, to carry traffic from a specific TDM port by means of a pseudowire, it is necessary to assign the same timeslots on the TDM side and on the pseudowire side. The pseudowire

timeslot assignment is made as part of the pseudowire configuration procedure, and it determines the cross-connect operations performed by the pseudowire cross-connect matrix (see below).

MPW-1 has a total of eight internal DS1 ports, each capable of handling 32 64 kbps timeslots. The user can independently configure each internal DS1 port in accordance with the desired operation mode:

- Framed mode, which enables individual handling of each port timeslot, or unframed (all the 32 timeslots of the port handled as a whole, and cross-connected to the same destination port)
- Signaling transfer: enabled or disabled. The MPW-1 module itself does not process signaling information: all the necessary processing is performed under the control of the CL module, either at the source TDM port or within the CL module itself. Therefore, all the Megaplex-4100 signaling processing features, including use of signaling profiles, are also effective for traffic transferred over pseudowires by means of MPW-1 modules (see the *Megaplex-4100 Installation and Operation Manual* for details).

Pseudowire Cross-Connect Matrix

The pseudowire cross-connect matrix is a timeslot cross-connect matrix similar to the TDM cross-connect matrix, which routes traffic from the internal DS1 ports to the pseudowire packet processors.

The cross-connect operations are configured as part of the attachment circuit parameters for each pseudowire.

Packet Processing Subsystem

The packet processors in the MPW-1 packet processing subsystem perform the functions necessary to convert TDM traffic directed to the MPW-1 internal DS1 ports to packetized traffic for transmission over pseudowires.

The maximum number of pseudowires that can be processed for each DS1 port, provided the port uses the DS0 cross-connect mode, is 16 (only one pseudowire is supported when the port uses the DS1 cross-connect mode).

A pseudowire can process traffic from only one internal DS1 port.

Each pseudowire has a header whose structure depends on the selected PSN type, and includes ***labels*** that specify the uniquely specify the pseudowire source and destination, in accordance with the following rules:

- When the PSN type is UDP/IP, the user-specified labels are in the range of 1 to 8063. The pseudowire labels determine the UDP port numbers, as explained in the *Determining UDP Port Numbers Used by Pseudowires* section
- When the PSN type is MPLS/ETH, the user-specified labels are used as MPLS labels (these labels are always located at the bottom of the MPLS label stack). The allowed range for pseudowire labels is then 16 to 1048575.

Note *Different source and destination labels can be used. In this case, it is necessary to ensure that the source (inbound) label selected at one pseudowire endpoint is*

configured as the destination (outbound) label at the other pseudowire endpoint, and vice versa.

Each pseudowire is handled in accordance with the user-configured PSN parameters (see the *PSN Configuration Parameters* section), considering the user-selected pseudowire parameters, and the framing and signaling mode of the associated internal DS1 port. The processing details for each pseudowire protocol are presented below.

TDMoPSN Processing

The main functions performed by the packet processor when using the TDMoPSN mode are as follows:

- In the transmit-to-network direction:
  - Processes the data stream received through the internal DS1 port to generate pseudowires, as specified by the user. When using a framed mode, the user can specify the timeslots to be transported end-to-end.

    To prepare a pseudowire, the packet processor extracts segments from the continuous data stream for insertion into the pseudowire payload section.

    The size of the pseudowire payload section is specified by the user ($n \times 48$ bytes, where n is 1 to 30):
    - When operating in a framed mode, the slices are formed by collecting the appropriate timeslots from consecutive frames until the TDM payload section of the packet is filled. Timeslot 0 is never included; timeslot 16 is processed in accordance with the signaling mode.
    - When operating in the unframed mode, the slices are formed by collecting consecutive bytes from the received DS1 stream until the TDM payload section of the packet is filled.
  - Adds the overhead necessary to transmit each slice over the packet switched network (either UDP/IP or MPLS/ETH), and builds TDMoIP, respectively TDMoMPLS, packets for transmission to the desired destination. The resulting packets are encapsulated as TDMoPSN over Ethernet, and then sent to the Ethernet switching subsystem of the module.
  - When signaling transport is enabled and the pseudowire timeslots are defined as voice timeslots, the signaling information associated with the timeslots transported by the pseudowire is also inserted in the packet.
- In the receive-from-network direction:
  - The TDMoPSN packets retrieved from the received Ethernet frames are stored in a packet buffer. Each pseudowire has its own buffer.

    The function of this buffer is to enable the packet processor to read the received packets at the rate of the original data stream of each pseudowire, and thus eliminate jitter in their arrival times. Therefore, this buffer is called ***jitter buffer***.

- The packet processor recovers the payload carried by the packets and restores the original data stream of the pseudowire, in accordance with the selected framing mode.

  When the pseudowire carries only selected timeslots, the payload is reinserted in the appropriate timeslots. Therefore, when several pseudowires carry payloads destined to the same internal DS1 port, all the useful payload is reinserted in the original timeslots, and only the remaining empty timeslots in the internal port frame are filled with a user-selectable idle code.

  In a similar way, the signaling information related to the voice timeslots transported by each pseudowire is reinserted in the positions corresponding to the pseudowire timeslots.

  Since the TDMoPSN packet structure for framed ports does not depend on the port frame structure, a pseudowire carrying traffic from an E1 port can be directed to a T1 port at the far end, as long as the total number of timeslots does not exceed 24, and the payload type is data (signaling cannot be transferred between E1 and T1 ports).

HDLCoPSN Processing

HDLCoPSN packet processing is similar to the processing of TDMoPSN packets described above, except that the HDLCoPSN protocol is intended to provide port-to-port transport of HDLC-encapsulated traffic, in accordance with RFC4618, for example, Frame Relay or CCS protocols.

For framed ports, the HDLC traffic is carried in specific timeslots (these timeslots are specified during the configuration of a HDLCoPSN pseudowire and are always considered data timeslots).

Note *For HDLCoPSN, it is not necessary to configure the same number of timeslots at the pseudowire end points. The pseudowire bandwidth will be determined by the endpoint with the smaller number of assigned timeslots.*

The HDLCoPSN protocol can also handle whole (unframed) E1 streams.

When assembling packets for a HDLC pseudowire, HDLC idle flags are removed, and only the contents of HDLC packets with useful payload are inserted in packets. This results in better bandwidth utilization efficiency. At the receive end, HDLC packet structure is restored and inserted in the restored port data stream. Therefore, HDLC pseudowires can connect only ports with the same framing mode.

SAToPSN Processing

SAToPSN is different from the TDMoPSN and HDLCoPSN protocols, in that it is used to transfer transparently a bit stream at the nominal port rate (2.048 Mbps). Therefore, SAToPSN can be used only when the port uses the unframed mode, and thus only one pseudowire can be configured per port.

SAToPSN packet payload consists of a user-specified number of raw TDM bytes (4 to 1440 bytes), and is treated as data payload.

Note *The SAToPSN packet overhead is large, and therefore, for efficient bandwidth utilization, the number of raw TDM bytes per packet should be as large as possible.*

The receiving end restores the original bit stream, and therefore a SAToPSN pseudowire can only be directed to another unframed E1 port, or to an n×64 kbps protocol (where *n* must be 32, that is, to a high-speed serial port operating at a rate of 2048 kbps).

CESoPSN Processing

CESoPSN transports raw TDM data, that is, packets are formed by inserting a user-specified number of complete TDM frames (4 to 360 frames) in the packet payload area. Therefore, CESoPSN pseudowires can only be configured on framed ports.

The TDM frames are considered as serial data, even if they carry voice and CAS. Since a CESoPSN pseudowire transports raw TDM frames, a CESoPSN pseudowire can only be directed to another E1 framed port.

Jitter Buffer Functions

The packets of each pseudowire are transmitted by MPW-1 at essentially fixed intervals towards the PSN. The packets are transported by the PSN and arrive to the far end after some delay. Ideally, the PSN transport delay should be constant: in this case, the packets arrive at regular intervals (these intervals are equal to the intervals at which they had been transmitted). However, in reality packets arrive at irregular intervals, because of variations in the network transmission delay. The term Packet Delay Variation (PDV) is used to designate the maximum expected deviation from the nominal arrival time of the packets at the far end device.

Note *The deviations from the nominal transmission delay experienced by packets are referred to as* ***jitter****, and the PDV is equal to the expected peak value of the jitter. Note however that nothing prevents the actual delay from exceeding the selected PDV value.*

To compensate for deviations from the expected packet arrival time, MPW-1 uses jitter buffers that temporarily store the packets arriving from the PSN (that is, from the far end equipment) before being transmitted to the local TDM equipment, to ensure that the TDM traffic is sent to the TDM side at a constant rate.

For each pseudowire, the jitter buffer must be configured to compensate for the jitter level expected to be introduced by the PSN, that is, the jitter buffer size determines the Packet Delay Variation Tolerance (PDVT).

Two conflicting requirements apply:

- Since packets arriving from the PSN are first stored in the jitter buffer before being transmitted to the TDM side, TDM traffic suffers an additional delay. The added delay time is equal to the jitter buffer size configured by the user.

- The jitter buffer is filled by the incoming packets and emptied out to fill the TDM stream. If the PSN jitter exceeds the configured jitter buffer size, underflow/overflow conditions occur, resulting in errors at the TDM side:
  - A jitter buffer overrun occurs when it receives a burst of packets that exceeds the configured jitter buffer size + packetization delay. When an overrun is detected, MPW-1 clears the jitter buffer, causing an underrun.
  - A jitter buffer underrun occurs when no packets are received for more than the configured jitter buffer size, or immediately after an overrun.

When the first packet is received, or immediately after an underrun, the buffer is automatically filled with a conditioning pattern up to the PDVT level in order to compensate for the underrun. Then, MPW-1 starts processing the packets and empty out the jitter buffer toward the TDM side.

To minimize the possibility of buffer overflow/underflow events, two conditions must be fulfilled:

- The buffer must have sufficient capacity. For this purpose, the buffer size can be selected by the user in accordance with the expected jitter characteristics, separately for each pseudowire, in the range of 0 to 200 msec.
- The read-out rate must be equal to the average rate at which frames are received from the network. For this purpose, the read-out rate must be continuously adapted to the packet rate, a function performed by the adaptive clock recovery mechanism of each packet processor.

Adaptive Timing

The receive path of each pseudowire must use a clock recovery mechanism to recover a clock signal at the original payload transmit rate used at the far end. This mechanism is referred to as ***adaptive clock recovery mechanism***.

The adaptive clock recovery mechanism estimates the average rate of the payload data received in the frames arriving from the packet-switched network. Assuming that the packet-switched network does not lose data, the average rate at which payload arrives will be equal to the rate at which payload is transmitted by the source.

Note

Generally, lost packets, as well as packets that did not arrive in the correct order, are replaced by special dummy packets. However, for CESoPSN and SAToPSN, packets can be reordered.

The method used to recover the payload clock of a pseudowire is based on monitoring the fill level of the selected pseudowire jitter buffer: the clock recovery mechanism monitors the buffer fill level, and generates a read-out clock signal with adjustable frequency. The frequency of this clock signal is adjusted so as to read frames out of the buffer at a rate that keeps the jitter buffer as near as possible to the half-full mark. This condition can be maintained only when the rate at which frames are loaded into the buffer is equal to the rate at which frames are removed. Therefore, the adaptive clock recovery mechanism actually recovers the original payload transmit clock.

The performance of the clock recovery mechanism can be optimized for the operating environment, by specifying the following parameters:

- The accuracy of the original timing source, in accordance with the standard SDH/SONET terminology (Stratum 1, 2, 3, 3E, or 4/unknown)
- The type of PSN that transports the traffic: router-based network (for example, UDP/IP) versus switch-based network (for example, MPLS/Ethernet).
- Handling of transient conditions: even after the adaptive clock recovery mechanism reaches a stable state, there may still be temporary changes in the network delay, which may occur on a timescale that does not allow for the mechanism to fully readjust. To provide the best possible user experience, the user can specify how to handle such transient conditions (a capability referred to as ***delay sensitivity***):
  - By disabling delay sensitivity, performance is optimized for accurate clock recovery. This selection is optimal for data transmission applications.
  - By enabling delay sensitivity, performance is optimized for constant delay. This selection is optimal for voice transmission applications.

For HDLCoPSN pseudowires, it is not necessary to restore the original data rate, because only useful HDLC payload (extracted from some of the HDLC frames reaching each endpoint) is transferred through the pseudowire, as explained in the *HDLCoPSN Processing* section. Therefore, the payload, which requires only a fraction of the available bandwidth, can be reinserted in timeslots at the receiving endpoint rate, without requiring any clock adaptation mechanism.

OAM Protocol

The OAM protocol, supported only by packet payload version V2, is used to check for a valid pseudowire connection: this includes checks for compatible configuration parameters at the packet processors at the two endpoints of a pseudowire, and detection of inactive pseudowire status. Therefore, the use of OAM must always be enabled when redundancy is used on MPW-1 modules.

The information regarding the pseudowire state is collected by the continuous, periodic handshake between the two endpoints of a pseudowire, which generates little traffic, but ensures that each endpoint recognizes the connection, and that it is enabled. In case no response is received to OAM packets within a predefined interval (a few tens of seconds), the pseudowire is declared inactive.

When the use of the OAM protocol is enabled, little traffic flows until the connection between the two pseudowire endpoints is established: only after the connection is confirmed by the OAM exchange is transmission at the normal (full) rate started, and the pseudowire starts carrying traffic. In case the connection is lost, the transmitted traffic is again significantly decreased (several packets per second per connection). Therefore, the OAM connectivity check also prevents network flooding in case the connection is lost.

OAM packets sent by MPW-1 are identified in accordance with the source port: the OAM packets run over a UDP port number (see the *Determining UDP Port Numbers Used by Pseudowires* section) that is assigned only to OAM traffic, but use the VLAN ID and ToS of the originating connection.

PSN Configuration Parameters

MPW-1 enables the user to select the PSN type (UDP/IP or MPLS/ETH), and configure the PSN transport parameters.

The PSN parameters, which are reflected in the pseudowire header structure, enable specifying the requested priority or quality of service for pseudowire traffic generated by the MPW-1. The applicable parameters depend on PSN type:

- When the PSN is based on Layer 2 forwarding, the user can specify the VLAN priority (per IEEE 802.1p) for the Ethernet frames carrying pseudowire packets. The priority is always selectable for traffic forwarded through the Megaplex-4100 GbE ports, because for these ports VLAN tagging is always enabled; when using other bridge ports as pseudowire exit ports, it is necessary to enable VLAN tagging in order to request a specific priority.
- When the PSN uses IP routing, the user can specify the Type of Service (ToS) per RFC791; if the PSN supports RFC2474, ToS is interpreted as a DiffServ codepoint per RFC2474.
- When the PSN uses MPLS, the user can specify the EXP bits. In addition, the user can also add ingress and egress tunnel labels, which enable network operators to plan preferential forwarding of pseudowire traffic using the specified tunnel labels.

Another parameter that may be used, for compatibility with older TDMoIP implementations, is the packet payload version, V1 or V2.

Ethernet Subsystem

The MPW-1 Ethernet subsystem, included in the functional block diagram shown in *Figure 1-6*, includes:

- External Ethernet ports
- Layer 2 Ethernet switching subsystem
- Internal Fast Ethernet data ports, used only when CL.1/GbE or CL.1/155GbE modules are installed in the chassis: each port connects to the Ethernet traffic handling subsystem of one CL module

Note *When neither CL.1/GbE, nor CL.1/155GbE modules, are installed in the Megaplex-4100 chassis, the internal Fast Ethernet ports are not used: in this case, pseudowires can be directed only to the external Ethernet ports of this MPW-1.*

- Internal Fast Ethernet management ports, connected to the Megaplex-4100 management subsystem on the CL modules. These ports are always active
- Ethernet termination and processing: provides the interface between the Layer 2 Ethernet switching subsystem and the local TDM cross-connect matrix

External Ethernet Ports

The external Ethernet ports have 10/100 Mbps interfaces capable of auto-negotiation. The user can configure the advertised data rate (10 or 100 Mbps) and operating mode (half-duplex or full-duplex). Alternatively,

auto-negotiation can be disabled, and the rate and operating mode be directly specified.

The Ethernet ports can be ordered with one of the following types of interfaces:

- 10/100BASE-TX interfaces terminated in RJ-45 connectors. In addition to auto-negotiation, MDI/MDIX polarity and cross-over detection and automatic cross-over correction are also supported. Therefore, these ports can always be connected through a "straight" (point-to-point) cable to any other type of 10/100BASE-T Ethernet port (hub or station).
- Sockets for SFP Fast Ethernet transceivers. RAD offers several types of SFPs with optical interfaces, for meeting a wide range of operational requirements. *Table 1-1* lists the RAD SFPs with optical interfaces recommended for use with MPW-1 (for a complete and current list of SFPs available from RAD, refer to the *RAD SFP Transceivers* data sheet). Most SFPs include DDM (Digital Diagnostic Monitor) and internal calibration.

Table 1-1. Optical Interface Characteristics of RAD SFPs

SFP Type and Operating Wavelength	Fiber Type	Transmitter Type	Input Power (dBm)		Output Power (dBm)		Typical Max. Range (km/miles)	Connector Type and Number of Fibers per Port
			min	max	min	max		
SFP-1 Tx/Rx: 1310nm	62.5/125 µm, multi-mode	LED	-30	-14	-20	-14	2/1.2	LC; two fibers
SFP-1D Tx/Rx: 1310nm	62.5/125 µm, multi-mode	LED	-30	-14	-20	-14	2/1.2	LC; two fibers
SFP-2 Tx/Rx: 1310nm	9/125 µm, single mode	Laser	-28	-8	-15	-8	15/9.3	LC; two fibers
SFP-2D Tx/Rx: 1310nm	9/125 µm, single mode	Laser	-28	-8	-15	-8	15/9.3	LC; two fibers
SFP-3 Tx/Rx: 1310nm	9/125 µm, single mode	Laser	-34	-10	-5	0	40/24.8	LC; single fiber
SFP-3D Tx/Rx: 1310nm	9/125 µm, single mode	Laser	-34	-10	-5	0	40/24.8	LC; single fiber
SFP-10a Tx: 1310nm Rx: 1550nm	9/125 µm, single mode	Laser (WDM)	-28	-8	-14	-8	20/12.4	LC; single fiber
SFP-10b Tx: 1550nm Rx: 1310nm	9/125 µm, single mode	Laser (WDM)	-28	-8	-14	-8	20/12.4	LC; single fiber
SFP-18A Tx: 1310nm Rx: 1550nm	9/125 µm, single mode	Laser (WDM)	-28	-8	-5	0	40/24.8	LC; single fiber
SFP-18B Tx: 1550nm Rx: 1310nm	9/125 µm, single mode	Laser (WDM)	-28	-8	-5	0	40/24.8	LC; single fiber

SFP Type and Operating Wavelength	Fiber Type	Transmitter Type	Input Power (dBm)		Output Power (dBm)		Typical Max. Range (km/miles)	Connector Type and Number of Fibers per Port
			min	max	min	max		
SFP-19A Tx: 1490nm Rx: 1570nm	9/125 µm, single mode	Laser (WDM)	-30	-8	0	+5	80/49.7	LC; single fiber
SFP-19B Tx: 1570nm Rx: 1490nm	9/125 µm, single mode	Laser (WDM)	-30	-8	0	+5	80/49.7	LC; two fibers

Note

It is strongly recommended to order MPW-1 with original RAD SFPs installed. This will ensure that prior to shipping, RAD has performed comprehensive functional quality tests on the entire assembled unit, including the SFP devices. RAD cannot guarantee full compliance to product specifications for units using non-RAD SFPs.

Note that RAD also offers Fast Ethernet SFPs with copper interfaces (with RJ-45 connector); however, when copper interfaces are needed, it is more cost-effective to order MPW-1 with 10/100BASE-TX interfaces.

Ethernet Layer 2 Switch Capabilities

The MPW-1 Ethernet switching subsystem fully complies with the IEEE 802.3/Ethernet V.2 standards, and has full VLAN support. The switching subsystem has memory-based switch fabric with true non-blocking switching performance. The subsystem collects a wide range of performance monitoring parameters, which can be read by management.

The switching subsystem ports are used as follows:

- Three ports are connected via transceivers to the external (ETH 1, ETH 2, and ETH 3) ports.
- Two Fast Ethernet ports connect to the CL module:
  - One Fast Ethernet port is connected to the Ethernet traffic handling subsystem of the CL modules installed in the Megaplex-4100 (only CL.1/GbE and CL.1/155GbE modules include an Ethernet traffic handling section). This connection enables the MPW-1 module to accept Ethernet traffic from other modules installed in the Megaplex-4100; therefore, when Megaplex-4100 uses CL.1 or CL.1/155 modules, only Ethernet traffic from the local MPW-1 Ethernet ports can be processed by the MPW-1.
  - The second Fast Ethernet port is connected to the management handling section of the CL modules installed in the Megaplex-4100 (this section is available on all CL modules).
  - One management port, connects to the MPW-1 local management subsystem.
  - One port connects to the module TDM cross-connect matrix, through the Ethernet termination and processing subsystem.

Each switching subsystem port is supported by an independent MAC controller that performs all the functions required by the IEEE 802.3 protocol.

The local Ethernet switching subsystem performs classification and switching functions among its ports. The Ethernet switch determines the destination of each frame in accordance with the configured Ethernet flows. The classification of each user network is based on the VLAN ID, or on the port, if no customer-side VLAN ID (C-VLAN) is configured. The switch will directly forward Ethernet traffic carrying locally-terminated pseudowires to local Ethernet ports; any other traffic will be forwarded through the MPW-1 Fast Ethernet data bus to the CL module, for processing by the CL module Ethernet traffic handling subsystem.

Ethernet Termination and Processing

The Ethernet termination and processing function provides an interface between the Ethernet switching subsystem and the local TDM cross-connect matrix: in the transmit direction, the payload received from TDM media is packetized and inserted in Ethernet frames for transmission to the appropriate Ethernet port. The reverse operation is performed for the incoming Ethernet frames.

Controlling Pseudowire Routing

The Megaplex-4100 router function is used to route pseudowire packets generated by the MPW-1 modules installed in the chassis to their destination. It also provides ARP services.

The terms and parameters needed by the Megaplex-4100 router function to support pseudowire routing are explained below:

- Router interfaces: the Megaplex-4100 router function supports up to 100 router interfaces, each assigned a unique index number. Each router interface has its own IP address; you must also specify an IP subnet mask, and the module and port on which interface is located.

  For each router interface, you can also enable the use of VLAN tagging and specify a VLAN ID, to enable differentiating the traffic carried by this router. Note that when the router interface is located on a GbE port or a VCG, VLAN tagging is always enabled.

  Each MPW-1 supports up to 6 different router interfaces; additional interfaces can be configured on any bridge port in the Megaplex-4100. The IP address of the appropriate interface is automatically inserted as the pseudowire source IP address.

Note *For Megaplex-4100 equipped with CL.1 or CL.1/155 modules, you can define router interfaces only on the Ethernet ports of the same MPW-1 module.*

- Pseudowire peers: the pseudowire destination is referred to as the pseudowire ***peer***. Megaplex-4100 supports up to 100 peers, each assigned a unique index number. The index number is then used to specify the pseudowire destination, instead of directly providing the necessary destination information. To configure a peer, it is necessary to provide its IP address, and as an option – the next hop IP address.

  Pay attention to the following points:

- Pseudowires configured on different MPW-1 modules must be configured with different peers, even if the destination address is the same.
- Different peers must not have the same destination IP address **and** the same next hop IP address (at least one of these parameters must be different). Therefore, if it necessary for several pseudowires to reach the same IP address, create separate router interfaces.

- **Static routes**: to control the paths used to reach the pseudowire destinations, the Megaplex-4100 router function supports the definition of up to 100 static routes, in addition to a default gateway. To ensure that only valid forwarding information is used, the user can configure the ARP aging time.

Within the Megaplex-4100, pseudowires are forwarded to the appropriate exit port (always a router interface) by internal E-line Ethernet flows (an E-line flow is a type of Ethernet logical connection that interconnects two bridge ports).

Note *Megaplex-4100 supports traffic and management flows. MPW-1 bridge ports can also serve the management flow. Unless specifically mentioned otherwise, in this manual the term* ***flow*** *means* ***traffic flow****.*

Each router interface serves as a bridge port for the pseudowires using it (in addition, each MPW-1 Ethernet port also serves as a bridge port).

Bridge ports which are router interfaces appear in automatically created Ethernet flows. Actually, defining a router interface automatically creates the Ethernet E-line flow needed to internally route the pseudowire from the MPW-1 module to the best suited router interface, considering the specified pseudowire peer.

To help you design the routing information, the following list summarizes the process used to select the router interface to be used for each pseudowire peer:

1. If the peer IP address is in the subnet of a router interface, that interface will always be used.
2. If the peer IP address is not within a router interface subnet, then the router checks if the specified peer next hop address is within the subnet of a router interface. If such a router interface is found, it is selected to serve as the pseudowire exit port.
3. If neither of the previous conditions are fulfilled, the router checks if the specified peer next hop address is specified in a static route that is within the subnet of a router interface.
4. The last priority is to use the router interface that is within the default gateway subnet.

Redundancy

The MPW-1 modules support dual-cable redundancy with parallel transmission (you can find additional details on redundancy schemes supported by Megaplex-4100 in the *Megaplex-4100 Installation and Operation Manual*). Since traffic is always connected through internal DS1 ports, the redundancy protection is configured on these ports.

Several redundancy protection topologies can be used, as described below.

Redundancy via PSN only

Figure 1-7 shows a topology which protects TDM traffic carried over PSN against failures in MPW-1 hardware, and in the transmission paths over PSN.

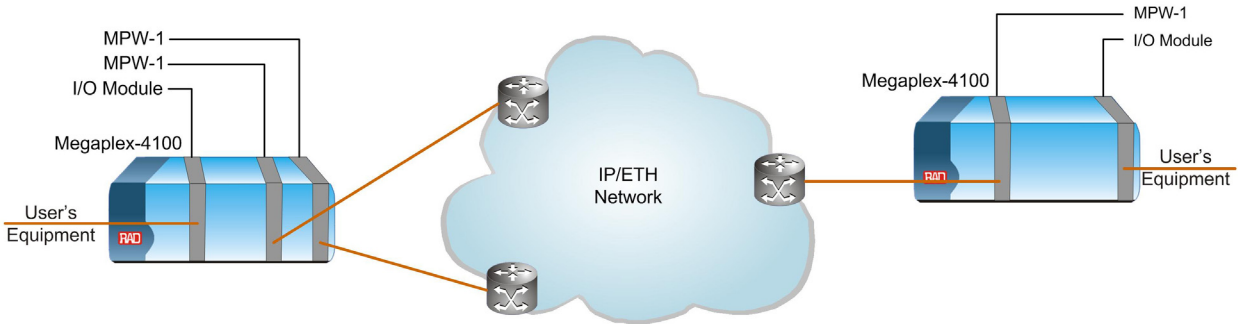


Figure 1-7. MPW-1 Redundancy – Hardware and Transmission Path Protection via PSN

To illustrate the flexibility of the redundancy schemes available for the MPW-1, hardware redundancy is used only at the West side:

- At the West side, two MPW-1 are used, and the redundancy is configured on internal DS1 ports located on different MPW-1 modules
- The East side uses a single MPW-1, and therefore supports only transmission path redundancy. For this mode, redundancy is configured on internal DS1 ports located on the same MPW-1.
- To enable hardware redundancy at the East side, it is necessary to install two MPW-1 modules, same as at the West side.

Note *When MPW-1 external Fast Ethernet ports are directly connected to the PSN, true hardware redundancy is always possible. When MPW-1 connection to the PSN is provided through bridge ports on other modules, true hardware redundancy is available only when redundancy is also enabled on the other modules. For example, when the connection is made via the GbE ports of CL.1/155GbE modules, redundancy for the CL.1/155GbE PSN interface must also be enabled.*

For each redundancy pair, the user must first configure the internal DS1 port that will serve as the primary port: the configuration prepared for the primary internal DS1 port is copied to the other port of the pair. In addition, it is necessary to configure pseudowires from each internal DS1 port in the redundancy pair to the desired destinations. Make sure to enable OAM, which is essential to proper operation of the redundancy feature (see the *OAM Protocol* section).

The pseudowires serving the standby (offline) internal DS1 port carry only OAM packets, which require relatively little bandwidth. When a problem causes switching to standby, the traffic is switched to the standby pseudowires, and the offline pseudowires attempt to transmit OAM packets.

Redundancy switching (*flipping*) is always revertive: after the failure is corrected, the primary port becomes again the active port.

Upon turn-on, the first port to enter normal operation is selected as the active (online) port of the pair. Thus, if this port is not the primary port, when the primary port starts normal operation flipping occurs and the primary port is selected as the active port.

Redundancy via PSN and TDM (E1) Networks

The dual-cable, parallel transmission redundancy mode supported by Megaplex-4100 enables protecting traffic over different media. Therefore, a MPW-1 internal DS1 port can be the redundancy partner of an E1 or PDH port on another I/O, respectively CL, module. This could be used in two ways, depending on the application requirements:

- To add protection for selected E1 links when no TDM transport capacity can be assigned for redundancy, MPW-1 modules may be used to provide the protection over the PSN. For purpose, the E1 port to be protected would be configured as the primary port, and an internal DS1 port of a MPW-1 will be assigned and configured as the protection (offline) port. This ensures that unless a fault occurs, the transmission quality is that available over TDM links, and very little bandwidth is consumed on the PSN.
- When some TDM transport capacity is available, it is possible to add protection for critical traffic carried by means of MPW-1 modules over the PSN, without using the same media (PSN) for protection. In this case, MPW-1 internal DS1 ports are configured as the primary ports, and E1 ports are configured as the protection ports.

Application Guidelines

Bandwidth Utilization Considerations

When selecting parameters for a new pseudowire, one of the critical parameters is the payload size, which is determined by the number of TDM bytes per packet. This parameter affects several important performance aspects:

- Bandwidth utilization: because of the relatively short payload (especially relevant for TDMoPSN and HDLCoPSN), the bandwidth utilization efficiency depends on the overhead that must be transmitted to the network in order to support the transmission of a certain amount of payload.
  - The overhead depends on the packet structure: for example, for UDP/IP networks the overhead is 50 bytes when using VLANs, and 46 bytes without VLANs
  - The payload depends on the number of TDM bytes, and varies between 48 to 1440 bytes.

  For example, when using the minimum payload size (48 bytes), bandwidth utilization efficiency is around 50%.
- Packetizing delay and the associated delay variance. Bandwidth utilization efficiency increases when using a large payload size per frame. However, there are additional aspects that must be considered when selecting the size of the packet payload:
  - Packetization time: the packet filling time, which is the time needed to load the payload into an Ethernet frame, increases in direct proportion to the number of bytes in the packet payload. This is particularly significant for pseudowires with few timeslots; for example, a voice channel could be carried by a single-timeslot pseudowire. Considering the nominal filling rate (approximately one byte every 0.125 msec), the time needed to fill a single-timeslot TDMoPSN pseudowire is as follows:

- At 48 TDM bytes per frame: 5.5 msec when signaling is transferred, and 5.9 msec without signaling
- At 384 TDM bytes per frame: 44 msec when signaling is transferred, and 47 msec without signaling

Therefore, for pseudowires with a few timeslots, it is recommended to use the minimum payload size (48 bytes).

In general, the TDMoPSN packetization delay is calculated with the following formula:

$$\text{Packetization delay (ms)} = \frac{47 \times N \times 0.125}{TS}$$

where **N** is the selected multiplier, 1 to 30:

$$N = \frac{\text{TDM bytes/frame}}{48}$$

and **TS** is the number of assigned timeslots.

Therefore, before considering any other delays encountered along the end-to-end transmission path, the round-trip (or echo) delay for the voice channel example presented above is 92 msec at 384 TDM bytes per frame (including the additional intrinsic delay of module – see below).

Such long delays may also cause time-out in certain data transmission protocols.

- **Intrinsic jitter**: the transmission of packets to the network is performed at nominally equal intervals (usually, the interval is 1 msec). This means that every 1 msec the packet processor sends to the network all the frames ready for transmission. As a result, the actual payload transmission intervals vary in an apparently random way whose peak value depends on the pseudowire size, an effect called *delay variance* (or jitter).

  For example, a pseudowire with 6 timeslots will fill a 48-byte payload field of an Ethernet frame every 1 msec. If the sending instants are not perfectly synchronized with the filling instants, the sending time will sometimes occur just in time and sometimes will be delayed by 1 msec relative to the ideal, creating a peak delay variance of 1 msec at the transmitting side.

  The intrinsic jitter in other cases is lower, therefore the delay variance generated by the MPW-1 modules will not exceed 2 msec.

- **Round-trip delay**. The round-trip delay for the voice path, in milliseconds, is calculated as follows:

  2 × [“Packetization Delay” + “Jitter Buffer Size” + 1] + “PSN Round Trip Delay”

  The actual value is within ±2 msec of the calculated value.

Sometimes, it is necessary to evaluate the transmission bandwidth required on the PSN, which also depends on the number of TDM bytes. Use the following formula:

Bandwidth (bps) = [(Frame Overhead (bytes) + TDM Bytes/Frame) × 8] × Frames/Second

The frame overhead and the number of TDM bytes per frame have already been presented; the additional parameter is the number of frames per second, which assumes the following values:

- Unframed E1 stream: **5447/N**, where **N** is the multiplier of 48 bytes specified when selecting the number of TDM bytes per frame
- Framed E1 stream: **8000 × k/47N**, where **k** is the number of timeslots assigned to the pseudowire.

Determining UDP Port Numbers Used by Pseudowires

For UDP/IP networks, the pseudowire label determines the source UDP port of a pseudowire (at the other endpoint of the pseudowire, this port number must then be inserted as the destination port). The method used to assign the source UDP port is as follows (unless explicitly stated otherwise, all the numbers are in hexadecimal notation):

- **For TDMoIP CE pseudowires using packet payload Version V1:**

  During normal operation, the source UDP port is given by:

  UDP Source Port = Pseudowire Label + 1

  This means that during normal operation, the UDP ports numbers are in the range of 0 to 8191 decimal.

  While the pseudowire is in the local fail state, the source UDP port changes to:

  UDP Source Port = Pseudowire Label + 8000

  This means that in the local fail state, the UDP ports numbers are higher than 8000 hexa (32768 decimal).

- **For TDMoIP CE pseudowires using packet payload Version V2:**

  UDP Source Port = Pseudowire Label + 2000

  This means that for TDMoIP CE pseudowires, all the UDP ports numbers are higher than 2000 hexa (8192 decimal). This also applies to HDLCoPSN.

  When application requirements cause the MPW-1 module to send to the same peer (destination IP address) packets using both payload version V1 and payload version V2, there is a potential for conflict. For example:

  - When you assign a certain label (for example, **Out PW Label** is set to 100) to a pseudowire using payload Version V1, the source UDP port is 101
  - Now, you cannot assign the next label (**Out PW Label** of 101 in this example) to a pseudowire using payload Version V2, because the resulting source UDP port is also 101

  So, it is always necessary to must skip (never use) the pseudowire label next to the label assigned to a pseudowire using payload Version V1, if the next pseudowire uses payload Version V2.

- **For CESoPSN and SAToPSN pseudowires using packet payload Version V2:**

  UDP Source Port = Pseudowire Number + C000

  This means that all the UDP ports numbers are higher than C000 hexa (49152 decimal).

MPW-1 Timing Subsystem

The MPW-1 timing subsystem performs the following main functions:

- Generates the clock and timing signals required by the transmit paths of the module. These signals are locked to the Megaplex-4100 nodal timing.
- Can generate reference clock signals for the nodal Megaplex-4100 timing subsystem, derived from the recovered clock signals of user-selected pseudowires (see the *Adaptive Timing* section), in accordance with the commands received from the CL module.

MPW-1 Local Management Subsystem

The local management subsystem performs two main functions:

- Controls the operation of the various circuits located on the MPW-1 module in accordance with the commands received from the CL module through the Megaplex-4100 management channel.
- Stores the application software of the MPW-1 module. The software can be updated through the CL module.
- Controls the routing of management traffic through the MPW-1. MPW-1 supports the transfer of management traffic, inband, for both TDM and Ethernet applications:
  - Inband management through MPW-1 Ethernet ports and associated router interfaces, which are included in the management flow configured by the user on the Megaplex-4100.
  - One dedicated management timeslot can be assigned on each internal DS1 port operating in a framed mode. This enables extending the management connections, through a pseudowire that carries the management timeslot, to other RAD equipment using inband management over dedicate timeslots. Thus, remote RAD equipment with E1 and T1 interfaces connected through pseudowires to the local Megaplex-4100 can also be managed inband, using a dedicated timeslot, by the same network management system that manages the local Megaplex-4100, for example, RADview.

MPW-1 Diagnostic Functions

The MPW-1 module panel includes indicators that display the status of Ethernet interfaces (see details in *Section 1.2*).

The MPW-1 module includes the following diagnostic functions:

- Self-test upon power-up
- Local and remote loopbacks on selected timeslots of the internal DS1 port level that can be controlled by the operator using Megaplex-4100 system management
- Ping test, which enable checking the IP connectivity to the pseudowire destination IP address from the MPW-1 packet ports.

1.4 Technical Specifications

General

Function	TDM pseudowire access gateway with internal ports
Internal TDM Ports	8 internal DS1 ports, with 32 timeslots per port (258 timeslots total, equivalent to 8×2.048 Mbps)
Internal Packet Ports	Two Fast Ethernet internal ports toward the packet (StarLAN) bus
External Packet Ports	Three 10/100 Mbps ports
Number of Pseudowires	• Up to 16 active pseudowires per Internal DS1 port • Up to 128 pseudowires per MPW-1 • Up to 640 pseudowires per Megaplex-4100
Pseudowire Protocols	• TDMoIP in accordance with RFC5087 • TDMoMPLS in accordance with RFC5087 and ITU-T Rec. Y.1413 • HDLCoPSN in accordance with RFC5087 and RFC4618 (except Clause 5.3 – PPP) • CESoPSN in accordance with RFC5086 • SAToPSN in accordance with RFC4553
Packet Switched Network Types	• UDP over IP • MPLS over ETH
Jitter Buffer Size	User-configurable per pseudowire: • Unframed mode: 0.5 to 200 msec, with 1-µsec granularity • Framed modes: 2.5 to 200 msec, with 1-µsec granularity
Clock Modes	• Based on Megaplex-4100 nodal timing • Independent adaptive clock recovery mechanisms per pseudowire, recovered clock can serve as Megaplex-4100 nodal timing clock source

Payload Routing	*Packet Routing*	• Static routing (up to 100 static routes per Megaplex-4100) • Up to 6 router interfaces per MPW-1, and up to 100 router interfaces per Megaplex-4100 (each router interface has its own source IP address) • Up to 100 pseudowire destinations (peers) per Megaplex-4100
	Exit Ports	• User-defined internal routing (any packet processor to any external Fast Ethernet port), and connection parameters (each pseudowire to any destination) • For Megaplex-4100 with GbE ports: in accordance with user-defined flows, to any bridge port in Megaplex-4100
Ethernet Interfaces	*Number of Ports*	Three 10/100 Mbps ports (either fiber-optic or copper, in accordance with order)
	Data Rate and Mode	10 or 100 Mbps, half- or full-duplex, selected by auto-negotiation or configured by the user
	Maximum Frame Size	1600 bytes
	Fiber Optic Ports	Hot-swappable SFPs ***Note**: For detailed specifications of the SFP transceivers, see Table 1-1 and RAD SFP Transceivers data sheet. RJ-45 copper interfaces also available as SFPs (model SFP-9F)*
	Copper Ports	
	Type	10/100Base-TX
	Connector	Shielded RJ-45 ***Note**: RJ-45 copper interfaces are also available for MPW-1 with SFP sockets (RAD SFP model SFP-9F)*
	Indicators (per Ethernet port)	• ACT (yellow): flashes in accordance with the transmit and/or receive activity on the corresponding port • LINK (green): lights when the link integrity signal is detected by the corresponding port
Diagnostics	*User-Controlled Port Loopbacks*	• Local loopback per selected timeslots on each internal DS1 port • Remote loopback per selected timeslots on each internal DS1 port
Configuration		Programmable via Megaplex-4100 management system

Chapter 2
Installation

This Chapter provides installation and setup instructions for MPW-1 modules.

The information presented in this Chapter supplements the general Megaplex-4100 installation, configuration and operation instructions contained in the *Megaplex-4100 Installation and Operation Manual*.

2.1 Installing the Module

MPW-1 modules may be installed in an operating unit (hot insertion).

Warning

Before performing any internal settings, adjustment, maintenance, or repairs, first disconnect all the cables from the module, and then remove the module from the Megaplex enclosure.
No internal settings, adjustment, maintenance, and repairs may be performed by either the operator or the user; such activities may be performed only by a skilled technician who is aware of the hazards involved.
Always observe standard safety precautions during installation, operation, and maintenance of this product.

Caution

The MPW-1 module contains components sensitive to electrostatic discharge (ESD). To prevent ESD damage, always hold the module by its sides, and do not touch the module components or connectors.

Caution

To prevent physical damage to the electronic components assembled on the two sides of the module printed circuit boards (PCB) while it is inserted into its chassis slot, support the module while sliding it into position and make sure that its components do not touch the chassis structure, nor other modules.

Preparations for Installation

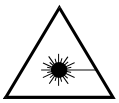
No preparations are required for MPW-1 modules with RJ-45 copper interfaces.

For MPW-1 modules equipped with SFPs, it may be necessary to install, or replace, SFPs.

MPW-1 modules have three installation positions for SFPs, designated ETH1, ETH2, and ETH3:

- To install an SFP, use the procedure given in the *Installing an SFP* section.
- To replace an SFP, use the procedure given in the *Replacing an SFP* section.

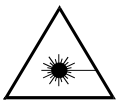
MPW-1 modules equipped with RAD-supplied SFP plug-in modules comply with laser product performance standards set by government agencies for Class 1 laser products. The modules do not emit hazardous light, and the beam is totally enclosed during all operating modes of customer operation and maintenance.



Warning

Third-party SFP optical transceivers may be also used, provided they are approved by an internationally recognized regulatory agency, and comply with the national laser safety regulations for Class 1 laser equipment. However, RAD strongly recommends ordering the MPW-1 with RAD SFPs, as this permits full performance testing of the supplied equipment.

MPW-1 modules are shipped with protective covers installed on all the optical connectors. Keep the covers for reuse, to reinstall the cover over the optical connector as soon as the optical cable is disconnected.



Warning

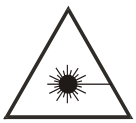
SFPs installed on MPW-1 modules may be equipped with a laser diode. In such cases, a label with the laser class and other warnings as applicable will be attached near the optical transmitter. The laser warning symbol may be also attached.

For your safety:

- **Before turning on the equipment, make sure that the fiber optic cable is intact and is connected to the optical transmitter.**
- **Do not use broken or unterminated fiber-optic cables/connectors.**
- **Do not look straight at the laser beam, and do not look directly into the optical connectors while the module is operating.**
- **Do not attempt to adjust the laser drive current.**
- **The use of optical instruments with this product will increase eye hazard. Laser power up to 1 mW could be collected by an optical instrument.**
- **Use of controls or adjustment or performing procedures other than those specified herein may result in hazardous radiation exposure.**

ATTENTION: The laser beam may be invisible!

Installing an SFP



Warning

When installing an optical SFP in an operating module, be aware that it may immediately start generating laser radiation.

Caution

During the installation of an SFP with optical interfaces, make sure that all the optical connectors are closed by protective caps.

Do not remove the covers until you are ready to connect optical fibers to the connectors. Be aware that when inserting an SFP into a working module, the SFP transmitter may start transmitting as soon as it is inserted.

Note

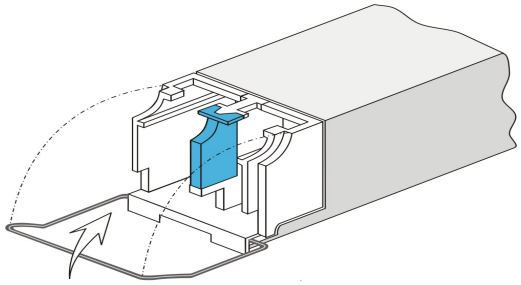
All the following procedures are illustrated for typical SFPs with optical interfaces. Your SFPs may look different.

To install the SFP:

1. Lock the latch wire of the SFP module by lifting it up until it clicks into place, as illustrated in *Figure 2-1*.

Note *Some SFP models have a plastic door instead of a latch wire.*

Figure 2-1. Locking the Latch Wire of a Typical SFP



2. Carefully remove the dust covers from the corresponding SFP socket of the MPW-1 module, and from the SFP electrical connector.
3. Orient the SFP as shown in *Figure 2-1*, and then insert the rear end of the SFP into the module socket.
4. Push SFP slowly backwards to mate the connectors, until the SFP clicks into place. If you feel resistance before the connectors are fully mated, retract the SFP using the latch wire as a pulling handle, and then repeat the procedure.
5. If necessary, repeat the procedure for the other SFP(s).

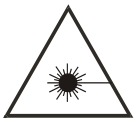
Replacing an SFP

SFPs can be hot-swapped. It is always recommended to coordinate SFP replacement with the system administrator. Note that during the replacement of SFPs, only the traffic on the affected ETH link is disrupted (the other ETH link can continue to carry traffic).

➤ **To replace an SFP:**

1. If necessary, disconnect any cables connected to the SFP connectors.
2. Push down the SFP locking wire, and then pull the SFP out.
3. Reinstall protective covers on the SFP electrical and optical connectors.
4. Install the replacement SFP in accordance with the *Installing an SFP* section.

Module Installation Procedure



Warning

The MPW-1 module starts operating as soon as it is inserted in an operating chassis.

➤ **To install an MPW-1 module:**

1. Refer to the system installation plan and identify the prescribed module slot.
2. Check that the fastening screws at the module sides are free to move.

3. Insert the MPW-1 module in its slot and slide it backward as far as it goes.
4. Secure the MPW-1 module by tightening its two fastening screws.
5. The module starts operating as soon as it is plugged into an operating enclosure. At this stage, ignore the alarm indications.

2.2 Connecting to MPW-1 Modules

Connecting User's Equipment to MPW-1 Ethernet Ports

Before starting, review the general optical cable handling instructions section in *Chapter 2* of the *Megaplex-4100 Installation and Operation Manual*. Identify the cables intended for connection to each Ethernet port of this module, in accordance with the site installation plan.

➤ **To connect cables to the optical Ethernet ports:**

1. Connect each prescribed cable to the corresponding MPW-1 connector, ETH1, ETH2 or ETH3. When two fibers are used, pay attention to connector polarity: the transmitter output is at left-hand side.

Connecting Users' Equipment to Electrical Ethernet Ports

Each MPW-1 electrical ETH port has a 10/100BASE-TX Ethernet interface terminated in an RJ-45 connector. The port supports the MDI/MDIX crossover function, and therefore it can be connected by any type of cable (straight or crossed) to any type of 10/100BASE-TX Ethernet port. The port also corrects for polarity reversal in the 10BASE-T mode.

Connector pin functions for the MDI state are listed in *Table 2-1*. In the MDIX state, the receive and transmit pairs are interchanged.

Table 2-1. ETH Connector, Pin Functions

Pin	Designation	Function
1	TxD+	Transmit Data output, + wire
2	TxD–	Transmit Data output, – wire
3	RxD+	Receive Data input, + wire
4, 5	–	Not connected
6	RxD–	Receive Data input, – wire
7, 8	–	Not connected

➤ **To connect cables to the MPW-1 electrical Ethernet ports:**

1. Connect the prescribed cable to the corresponding connector, ETH1, ETH2 or ETH3.

Chapter 3

Configuration

This Chapter provides specific configuration information for MPW-1 modules.

The configuration activities are performed by means of the management system used to control the Megaplex-4100 unit.

For general instructions, additional configuration procedures, and background information, refer to the *Megaplex-4100 Installation and Operation Manual*.

Notes

- *MPW-1 modules provide pseudowire services to the other modules installed in the Megaplex-4100. Therefore, before configuring MPW-1 modules it is recommended to configure the other Megaplex-4100 modules and services. In particular, make sure to configure Ethernet services.*
- *Make sure to plan ahead the configuration sequence, because Megaplex-4100 databases can be updated only after correctly completing the configuration activities: any sanity error will prevent saving the changes to the database being modified. For example, a common cause of sanity errors that may prevent updating the database is that timeslots have to be assigned to ports of other modules that will be served by the MPW-1 ports.*

MPW-1 configuration includes the following types of tasks:

- Tasks needed to configure an MPW-1 module and put it into service. These tasks include enabling the desired module physical ports, configuring their parameters, and configuring the utilization of the module TDM (internal DS1) ports.
- Tasks related to the provisioning of pseudowire services.
- When necessary, modify the system timing reference to use selected pseudowire connections for the Megaplex-4100.

The recommended configuration sequence for each type of task is described below, together with references to the supervision terminal screens used to perform each task.

➤ **To configure an MPW-1 module and put it into service (see *Section 3.3*):**

1. If necessary, program (add) an MPW-1 module not yet installed in the Megaplex-4100 chassis to the database.

   For the supervision terminal, use **Configuration > System > Card Type**.

2. Configure the physical layer parameters for the active internal DS1 and Ethernet ports of the MPW-1 module.

   For the supervision terminal, use **Configuration > Physical Layer > I/O**.

3. Configure the utilization of the module TDM ports:

1. For framed internal DS1 ports using the DS0 cross-connect mode: configure the utilization of the individual timeslots, including timeslots using split assignment, for each module port. You can assign timeslots only to ports already configured with **Administrative Status** set to **Up**.

Note *For MPW-1 internal DS1 ports using the DS1 cross-connect mode, the connection to another port is configured as part of the port physical layer parameters.*

For the supervision terminal, use **Configuration › Physical Layer › I/O › TS Assignment, or Configuration › System › TS Assignment**.

2. For internal DS1 ports that connect to PDH ports on a CL module with STM-1 or OC-3 links (CL.1/155 or CL.1/155GbE): configure the corresponding PDH port with compatible parameters (in particular, configure a compatible framing mode), and then map the PDH port to the prescribed TU of the specified SDH port.

   For the supervision terminal, use **Configuration › Logical Ports › CL**, and **Configuration › System › Mapping**, respectively (for instructions, refer to the *Megaplex-4100 Installation and Operation Manual*).

➤ **To configure pseudowire services on the module (see *Section 3.4*):**

1. Configure MPW-1 router parameters (interfaces, associated static routes, default gateway, and ARP aging time).

   For the supervision terminal, use **Configuration › Applications › Router**.

2. Configure the pseudowire peers (destinations).

   For the supervision terminal, use **Configuration › Applications › Multi-Service over PSN › Peers**.

3. Configure the pseudowires terminated at the MPW-1 internal DS1 ports.

   For the supervision terminal, use **Configuration › Applications › Multi-Service over PSN › PW**.

4. If necessary, configure fault propagation for the relevant MPW-1 pseudowires.

   For the supervision terminal, use **Configuration › System › Fault Propagation** (for additional instructions, refer to the *Megaplex-4100 Installation and Operation Manual*).

➤ **To configure pseudowires as system timing reference (see *Section 3.5*):**

1. When necessary, modify the system timing reference to use the recovered clock of an MPW-1 pseudowire as timing reference.

   For the supervision terminal, use **Configuration › System › Clock Source** (for additional information, see also the *Megaplex-4100 Installation and Operation Manual*).

3.1 Normal Indications

The status of each MPW-1 Ethernet port is indicated by a separate set of indicators. After the equipment connected to the module Ethernet ports is operational, the following indications should appear for each active port:

- The LINK indicator lights as long as the port is connected to operational equipment
- The ACT indicator may light continuously, or flash from time to time, in accordance with the transmit and receive activity at the corresponding port.

3.2 Default Settings

Table 3-1 lists the MPW-1 factory-default parameters.

Table 3-1. MPW-1 Factory-Default Parameters

Parameter	Description	Factory Default Value
	Internal DS1 Port – Physical Layer Configuration Parameters	
Administrative Status	Port administrative status	Down
Name	Port logical name	Empty string
Redundancy	Port redundancy mode	None
Primary	Port function in redundancy pair (relevant when redundancy is enabled)	None
Redundant Slot	Redundancy pair slot (relevant when redundancy is enabled)	CL
Redundant Port	Redundancy pair port (relevant when redundancy is enabled)	– (no port selected)
Wait to Restore	Time, in seconds, following the last redundancy time switching (flipping) during which alarms are ignored	300
Cross Connect	Handling of the data passing through the selected port	Framed mode: DS0 Unframed mode: DS1
Destination Slot	I/O slot to which data stream is routed (when using DS1 cross-connect mode)	CL
Destination Port	Port to which data stream is routed (when using DS1 cross-connect mode)	– (no port selected)
Framing	Handling mode of payload flowing through the selected internal DS1 port	Framed
Signaling	Support for signaling information (relevant when using a framed mode)	No

Parameter	Description	Factory Default Value
	Ethernet Port – Physical Layer Configuration Parameters	
Port Number	Ethernet port number	1
Administrative Status	Ethernet port administrative status	Down
Name	Ethernet port logical name	Empty string
Auto Negotiation	Ethernet port autonegotiation mode	Enable
Max. Capability Advertised	Highest traffic handling capability advertised when autonegotiation is enabled	100Mbps Full Duplex
Speed & Duplex	Ethernet port data rate and operating mode when autonegotiation is disabled	100Mbps Full Duplex
	Router Parameters	
Default Gateway	Default gateway IP address	0.0.0.0
ARP Aging Time (sec)	Aging time for ARP entries	1200
	Router Interface Parameters	
Number	Router interface index number	1
Name	Router interface logistic name	RI#1
IP Address	IP interface address	0.0.0.0
IP Mask	IP interface subnet mask	0.0.0.0
Slot	I/O slot of router interface	CL-A
Port	Router interface exit port	GbE-1
VLAN Tagging	VLAN tagging	Disable
VLAN ID	VLAN ID	1
	Static Routes Parameters	
Number	Static route index number	1
IP Address	Static route IP address	0.0.0.0
IP Mask	Static route IP subnet mask	0.0.0.0
Next Hop	Next hop IP address	0.0.0.0
	Peer Parameters	
Peer Number	Peer index number	1
Name	Peer logistic name	Peer-1
Peer IP Address	Peer IP address	0.0.0.0
Peer Next Hop Address	Peer next port IP address	0.0.0.0
	General Pseudowire Parameters	
PW Type	Pseudowire encapsulation protocol	TDMoIP CE
PSN Type	Pseudowire PSN header	UDP/IP

Parameter	Description	Factory Default Value
Peer Number	Pseudowire destination index number	1
OAM Mode	Pseudowire OAM support	Proprietary
Out PW Label	**UDP/IP:** UDP source port number. **MPLS/ETH:** outer (tunnel) MPLS label	1 16
In PW Label	**UDP/IP:** UDP destination port number. **MPLS/ETH:** inbound MPLS label	1 16
	Pseudowire PSN Parameters	
ToS	Layer 3 priority assigned to the traffic generated by this pseudowire (relevant only for UDP/IP PSN)	0
Ingress Tunnel Tagging	Use of an interworking MPLS label for the receive (inbound) direction of the pseudowire (relevant only for MPLS/ETH PSN)	Disable
Ingress Tunnel Label	Inbound MPLS label used for the pseudowire (relevant only for MPLS/ETH PSN)	16
Egress Tunnel Tagging	Use of an interworking MPLS label for the transmit (outbound) direction of the pseudowire (relevant only for MPLS/ETH PSN)	Disable
Egress Tunnel Label	Outbound MPLS label used for the pseudowire (relevant only for MPLS/ETH PSN)	16
EXP Bits	Value of the outbound EXP bits in the pseudowire MPLS pseudowire header, used to indicate the requested Quality of Service (relevant only for MPLS/ETH PSN)	0
VLAN Priority	Layer 2 priority assigned to the pseudowire traffic when **VLAN Tagging** is enabled	0
Payload Format	Packet payload format	V2
	Pseudowire Service Parameters	
TDM Bytes in Frame	Number of TDM payload bytes (TDM frames for CESoPSN) inserted in each packet (packet size)	TDMoIP: 1 × 48 CESoPSN: 4
Payload Size	TDM payload size	4 to 1440
Jitter Buffer	Value of the jitter buffer to be used on this pseudowire	2500
Far End Type	Framing used by the equipment at the destination endpoint	E1
Delay Sensitivity	Optimum mode of the clock recovery mechanism	Data
Voice OOS	Code transmitted during out-of-service periods on timeslots defined as voice timeslots	00
Data OOS	Code transmitted by the port during out-of-service periods on timeslots defined as data timeslots	00

Parameter	Description	Factory Default Value
OOS Signaling	State of signaling bits sent to the internal DS1 port connected to the selected pseudowire during out-of-service periods	Forced idle
	Attachment Circuit Parameters	
Slot	I/O slot number	IO-1
Int-DS1 Number	Internal DS1 port of the selected MPW-1	1
Time Slots	Pseudowire timeslot assignment	– (no timeslot assigned)
	Recovered Clock Source Parameters	
ID	Recovered clock source index number	1
PW Number	Pseudowire index number that will be the source with the selected index number	The first index number of an existing pseudowire
Administrative Status	Recovered clock source active or not	Down
Source Quality	Quality of original timing source	Stratum 4
Network Type	Type of packet switched network used to transport the pseudowire	Type B

3.3 Putting a New MPW-1 Module in Service

Adding an MPW-1 to Megaplex-4100 Database

➤ **To program an MPW-1 module in the Megaplex-4100 database:**

1. Navigate to the **Configuration > System > Card Type** screen.
2. Bring the cursor to the field of the prescribed I/O slot by clicking <**Tab**>, and then select **MPW-1.**
3. Update the Megaplex-4100 database, to save the new selection (type **%**, and then type **y** to confirm).

Note *If the programmed module is not yet installed in the Megaplex-4100, it is normal to get a warning message reporting a programmed/installed module mismatch.*

Configuring the Internal DS1 Ports

MPW-1 supports up to 8 internal DS1 ports, each capable of handling 32 timeslots.

Configuring Physical Layer Parameters of Internal DS1 Ports

➤ **To configure the physical layer parameters for the MPW-1 internal DS1 ports:**

1. Navigate to the **Configuration > Physical Layer > I/O** screen, and then select the I/O slot of the desired MPW-1.
2. Select the **Int DS1** option.

   You will see the configuration screen for the first internal DS1 port (the port with the lowest index number). Scroll using **F** and **B** to reach the desired port, or use the **Port Number** field to enter manually the desired port number, in the range of 1 to 8.

   You will see the configuration screen for the selected internal DS1 port.

Table 3-2 lists the MPW-1 internal DS1 physical layer port parameters.

Table 3-2. Internal DS1 Port Physical Layer Parameters

Parameter	Function	Values
Port Number	Selects the internal DS1 port to be configured	Opens a port selection screen that displays the available selections, 1 to 8. **Default: 1**

Parameter	Function	Values
Administrative Status	Used to enable/disable the selected port	**UP** — The flow of traffic through the selected port is enabled. **DOWN** — The flow of traffic through the selected port is disabled. This state should be selected as long as the port configuration has not yet been completed, or when it is necessary to stop traffic flow through the port. **Default: DOWN**
User Name	Used to assign a logical name to the selected port	Up to 32 alphanumerical characters. **Default: Empty string**
Redundancy	Controls the use of port redundancy. After redundancy is enabled, additional fields appear, for configuring redundancy parameters, and the redundancy partner slot and channel (port). Note that the redundancy status of the selected port (primary) appears in an additional read-only field. The first configured port of a redundancy pair always becomes the primary port: configuration parameters prepared for the primary port are then automatically copied to the other port as soon as the other port is specified, therefore, make sure to plan ahead the order in which ports are configured and always start configuring the primary port	**NONE –** Redundancy disabled for the port being configured. **DUAL CABLE P. TX** – Redundancy function is enabled. Each of the two ports in the redundancy pair is connected through a separate transmission path to the far end equipment, and when a fault occurs, the traffic is switched to the other port. The active port transmits the payload, whereas the data transmitted by the other (inactive, or standby) port depends on its type: • When the other port is an E1 or T1 port, it transmits in parallel the same payload. • When the other port is an internal DS1 port, the corresponding pseudowires transmit only OAM packets. **Default: NONE**
Primary	Displays the port function in a redundancy pair. This parameter is not displayed when **Redundancy** is **NONE**	**YES** – This port serves as the primary port of a redundancy pair. **NO** – This port serves as the alternative port of a redundancy pair. **Default: YES**
Redundant Slot	Selects the slot in which the other module of a redundancy pair is installed. The selection must always be symmetrical. This parameter is not displayed when **Redundancy** is **NONE**	The available selections are the CL modules installed in the chassis, and I/O 1 to I/O 10. **Default: CL**

Parameter	Function	Values
Redundant Port	Selects the other port of a redundancy pair. The selection must always be symmetrical. This parameter is not displayed when **Redundancy** is **NONE**	The available selections depend on the destination module and the number of active ports on the other module: • 1 to 8 for external and internal E1 or T1 ports • 1 to 8 for internal_DS1 ports • 1 to 63 PDH ports on a CL module using STM-1 links. • 1 to 84 for PDH ports on a CL module using OC-3 links. **Default: –** (no port selected)
Wait to Restore	Specifies the time following the last redundancy switching (flipping) during which alarms are ignored. Therefore, the module starts evaluating the criteria for redundancy switching (flipping) only after this interval expires. This ensures that another flipping cannot occur before the specified interval expires	The supported range is 0 to 999 seconds. **Default: 300**
Cross Connect	Selects the handling of the data passing through the selected port	**DS0 –** Enables routing each individual timeslot from this port to other module ports or pseudowires. This mode is not supported when using the **UNFRAMED** mode. **DS1 –** In the **UNFRAMED** mode, the data stream handled by this port is transparently connected to another port or pseudowire. In the **FRAMED** mode, only the payload timeslots are transparently connected. **Default: DS0 for FRAMED mode.** **DS1 for UNFRAMED mode**
Destination Slot	Specifies the module (I/O slot) to which the data stream handled by the selected port is routed. This parameter is displayed only when using the **DS1** cross-connect mode	The available selections are the CL modules installed in the chassis, and I/O modules IO-1 to IO-10. **Default: CL**
Destination Port	Specifies the port to which the data stream handled by the selected port is routed. This parameter is displayed only when using the **DS1** cross-connect mode	The available selections depend on the destination module and the number of active ports on the other module: • 1 to 8 for external and internal E1 or T1 ports • 1 to 8 for internal_DS1 ports • 1 to 63 PDH ports on a CL module using STM-1 links. • 1 to 84 for PDH ports on a CL module using OC-3 links. **Default: –** (no port selected)

Parameter	Function	Values
Framing	Selects the handling of the payload flowing through the selected internal DS1 port	**FRAMED** – Enables separate handling of each individual timeslot. In this mode, it is also possible to connect to either E1 ports or T1 ports (for T1 ports, the maximum is 24 timeslots). **UNFRAMED** – The port is considered as a whole (all its timeslots are handled as a single group). **Default: FRAMED**
Signaling	Specifies whether the selected internal DS1 port carries signaling information (for example, channel-associated signaling). This parameter is displayed only when using the **FRAMED** mode	**YES** – Port carries signaling information. Use this selection when port timeslots will be defined as **VOICE** timeslots. **NO** – No signaling information. **Default: NO**
TS Assignment	Displays the timeslot assignment submenu for this port	For instructions, refer to the *Configuring Internal DS1 Port Timeslot* Utilization section starting on page *3-11*

Redundancy Configuration Guidelines

The MPW-1 modules support redundancy for protecting the traffic flowing through each of its internal DS1 ports. The redundancy mode is always revertive, that is, the traffic is automatically switched back to the primary port as soon as it returns to normal operation (except for a delay selected by means of **Wait to Restore**).

The redundancy partner ports can be located either on the same module, or on another module, in which case it is also possible to use internal (logical) ports of other I/O or CL modules.

When using the redundancy feature, it is necessary to select the same values for the following parameters of the two ports configured as a redundancy pair:

- **Framing**
- **Signaling**
- **Voice OOS**
- **Data OOS**
- **Restoration Time**
- **Cross-Connect**

However, you can select different **Wait to Restore** times, because the times selected at the two ends should be different.

To save duplication of configuration parameters, all the parameters listed above are selectable only for the primary port. The parameters of the other (alternative) port are automatically copied from the primary port after the configuration of the primary port has been completed and the database has been updated.

The same is true with respect to timeslot assignment: only one port (either the primary or the secondary) must be configured, and the timeslot assignment is automatically copied to the other port.

Note that you can see the automatically changed parameters of the other port as soon as a redundancy partner is specified during the configuration of the primary

port, but the parameters are actually changed only when the database is updated.

To avoid redundancy configuration errors, use the following procedure:

1. Before starting the configuration of the redundancy parameters, decide which port of the planned redundancy pair is to serve as the primary port, and make sure that the other port does not carry traffic.

Note *You must always start configuring the primary port, and only after this port is fully configured, continue to the redundancy partner of the primary port.*

2. Fully configure the port that is to serve as the primary port. After parameters are configured, the redundancy slot, channel (port) and primary status indicator become read-only fields.

   In parallel, the parameters of the alternative port are also configured to compatible values.

3. After ending the configuration of the primary port, configure the alternative port. When you open the alternative port configuration screen, you will see read-only fields which display all the preconfigured parameters, and then the list of parameters that can be configured.

4. To change the redundancy assignments, first select **None** for the **Redundancy** parameter. This will enable you to reconfigure the system as required.

Configuring Internal DS1 Port Timeslot Utilization

The internal DS1 port provides a connection point between TDM traffic arriving from other modules and the pseudowires supported by MPW-1. Each pseudowire can be connected to only one internal DS1 port.

When an MPW-1 internal DS1 port uses the DS0 cross-connect mode (available when the port uses the **Framed** mode), it is necessary to connect individual timeslots to the prescribed ports on the other I/O and CL modules, in accordance with the application requirements (this action is referred to as ***timeslot assignment***). To continue the connection over the pseudowire, when you configure the pseudowire you also specify the internal DS1 port timeslots to be collected and processed by it. You can assign timeslots only to internal DS1 ports that have been already configured, and that have their **Administrative Status** set to **Up**.

For the supervision terminal, use the last item, **Time Slot Assignment**, on the **Configuration > Physical Layer > I/O** screen of the desired MPW-1 internal DS1 port, or use the **Configuration > System > TS Assignment** screen in accordance with the *Megaplex-4100 Installation and Operation Manual*.

Note *The connection of timeslots from the internal DS1 port to each local pseudowire is made using the **Time Slots** item on the **Configuration > Applications > Multi-Service over PSN > PW > Service Parameters > Attachment Circuit** screen.*

Timeslots can be assigned for the following purposes:

- For connection to any other port of an I/O or CL module that uses the DS0 cross-connect mode (for example, framed E1 or T1 ports), or an I/O channel

that supports connection of individual timeslots (for example, a high-speed data module).

For PDH ports, make sure to map the PDH port to the prescribed TU of the CL STM-1 or OC-3 port (for the supervision terminal, use **Configuration > System > Mapping**, using the instructions appearing in the *Megaplex-4100 Installation and Operation Manual*).

- For transferring inband management (relevant only for connections to other E1 or T1 ports). Only one management timeslot can be assigned per port

The available timeslot types are the same timeslots described for the **Configuration > System > TS Assignment** screen in the *Megaplex-4100 Installation and Operation Manual*.

Note that a timeslot assignment for a connection between two ports is accepted as valid only when it is symmetrical, that is, a suitable timeslot of the destination is also connected to the source port timeslot.

When using redundancy, timeslot assignment can be performed on either the primary or the secondary port, and the timeslot assignment is automatically copied to the redundancy partner of the primary port.

Configuring Internal DS1 Port Connections

An MPW-1 port using the DS1 cross-connect mode can only be connected to another port that uses the DS1 cross-connect mode and the same framing mode (**Framed** or **Unframed**).

Note that for ports using the DS1 cross-connect mode, the internal DS1 port bandwidth cannot be split among multiple pseudowires, and therefore the whole port bandwidth must be assigned to only one pseudowire. Although the internal DS1 port bandwidth is equivalent to 32 timeslots, the pseudowire bandwidth depends on the number of timeslots available at the other port:

- For E1 ports: 32 timeslots when using the **Unframed** mode, or 31 timeslots when using a **Framed** mode
- For T1 ports: 24 timeslots (possible only in the **Framed** mode)

The other port is specified as part of the port physical layer parameters. The following selections are supported:

- An external or internal port of another I/O module using the same framing mode
- A PDH port on a CL.1/155 or CL.1/155GbE module (relevant only for the **Framed** mode). The corresponding PDH must then be mapped to the prescribed TU of an STM-1 or OC-3 port. For the supervision terminal, use **Configuration > Logical Ports > CL**, and **Configuration > System > Mapping**, respectively (for instructions, refer to the *Megaplex-4100 Installation and Operation Manual*).

Configuring Physical Layer Parameters of Ethernet Ports

➤ **To configure the physical layer parameters for the MPW-1 Ethernet ports:**

1. Navigate to the **Configuration > Physical Layer > I/O** screen, and then select the I/O slot of the desired MPW-1.

2. Select the **Ethernet** ports configuration option, and then select a specific port.

   Alternatively, first preconfigure all the ports with the same basic parameters (**All Ports** option), and then sequentially select each port and change its parameters as required.

Table 3-3 describes the Ethernet port configuration parameters.

Table 3-3. Ethernet Port Physical Layer Configuration Parameters

Parameter	Function	Values
Port Number	The Ethernet port number	The available selections are 1 to 3, or **All Ports**. **Default: 1**
Administrative Status	Used to enable/disable the flow of traffic through the selected Ethernet port	**DOWN –** The flow of traffic is disabled. This state should be selected as long as the configuration of the corresponding port has not yet been completed, or when it is necessary to stop traffic flow through the port. **UP –** The flow of traffic is enabled. **Default: DOWN**
User Name	Used to enter a logical name for the selected Ethernet port	Up to 32 alphanumeric characters. **Default: Empty string**
Auto Negotiation	Controls the use of auto-negotiation for the selected Ethernet port. Auto-negotiation is used to select automatically the mode providing the highest possible traffic handling capability	**ENABLE –** Auto-negotiation is enabled. This is the normal operation mode. **DISABLE –** Auto-negotiation is disabled. This mode should be used only when the equipment connected to the port does not support auto-negotiation. **Default: ENABLE**
Max. Capability Advertised	When **Auto Negotiation** is **ENABLE**, selects the highest traffic handling capability to be advertised during the auto-negotiation process. The operating mode selected as a result of auto-negotiation cannot exceed the advertised capability. When **Auto Negotiation** is **DISABLE**, this parameter is replaced by **Speed & Duplex**	The available selections are listed in ascending order of capabilities: **10Mbps half duplex** – Half-duplex operation at 10 Mbps. **10Mbps full duplex** – Full-duplex operation at 10 Mbps. **100Mbps half duplex** – Half-duplex operation at 100 Mbps. **100Mbps full duplex** – Full-duplex operation at 100 Mbps. **Default: 100Mbps full duplex**
Speed & Duplex	When **Auto Negotiation** is **DISABLE**, selects the data rate and the operating mode of the selected Ethernet port. When **Auto Negotiation** is **ENABLE**, this parameter is replaced by **Max. Capability Advertised**	Same selections as for the **Max. Capability Advertised** parameter. **Default: 100Mbps full duplex**

3.4 Configuring Pseudowire Services

The pseudowire services enable converting TDM payload to packets and transferring these packets through router interfaces defined in the Megaplex-4100.

The pseudowire services supported by MPW-1 modules are configured by providing two main groups of parameters:

- Routing parameters for the Megaplex-4100 router function
- Pseudowire processing parameters

Defining a router interface creates automatically an Ethernet E-line flow, a type of Ethernet logical connection that interconnects two compatible network interfaces (called ***bridge ports*** on supervision terminal screens). Refer to *Section 3.6* for a description of Ethernet flows supporting pseudowires.

Configuring the Router Function to Support Pseudowire Services

With respect to MPW-1 modules, the Megaplex-4100 router function is used to route pseudowire packets to their destination (peer). It also provides ARP services.

Each MPW-1 supports up to 6 different router interfaces (additional interfaces can be configured on any bridge port in the Megaplex-4100 – see description of Ethernet services in the *Megaplex-4100 Installation and Operation Manual*). The IP address of the appropriate interface is automatically inserted as the pseudowire source IP address (the destination IP address is that of the pseudowire peer, as explained in the *Configuring the Pseudowire Peers* section).

Note *For Megaplex-4100 equipped with CL.1 or CL.1/155 modules, you can define router interfaces only on the Ethernet ports of the same MPW-1 module (only CL modules with GbE interfaces, that is, CL.1/155 or CL.1/155GbE, enable transferring Ethernet traffic between different I/O modules).*

To control the paths used to reach the pseudowire destinations, the MPW-1 router supports the definition of up to 100 static routes, in addition to a default gateway. To ensure that only valid forwarding information is used, the user can configure the ARP aging time.

To help you design the routing information, *Figure 3-1* summarizes the process used to select the router interface for each pseudowire peer. The priority of the various router interfaces, as determined by the routing process, is as follows:

1. If the peer IP address is in the subnet of a router interface, that interface will always be used.
2. If the peer IP address is not within a router interface subnet, then the router checks if the specified peer next hop address is within the subnet of a router interface.
3. If neither of the previous conditions are fulfilled, the router checks if the specified peer next hop address is specified in a static route that is within the subnet of a router interface.

4. The last priority is to use the router interface that is within the default gateway subnet.

Note *Each router interface serves as a bridge port for the pseudowires using it. These bridge ports appear in automatically created Ethernet flows – see Section 3.6.*

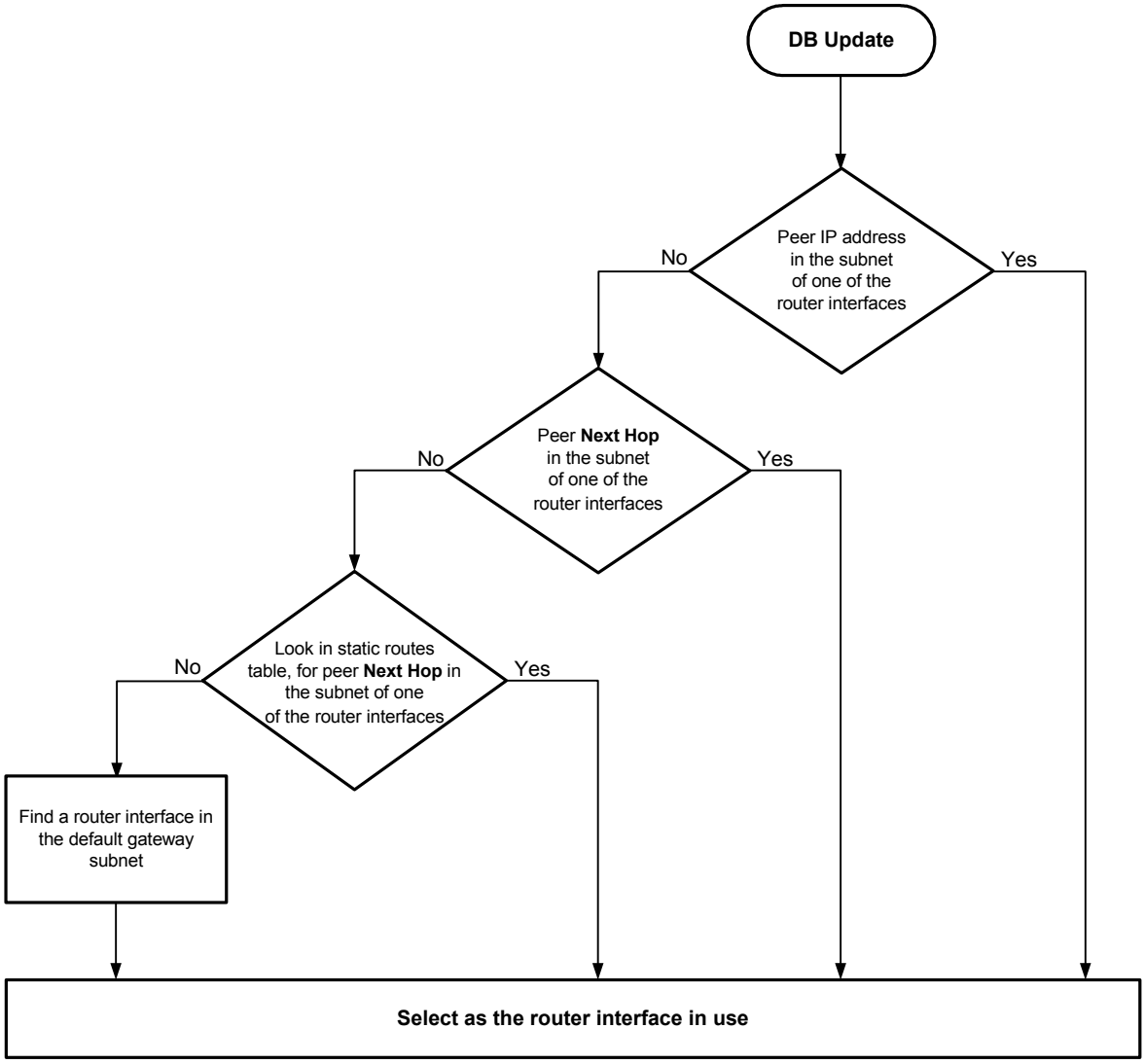

DB Update
Peer IP address in the subnet of one of the router interfaces
No
Yes
Peer Next Hop in the subnet of one of the router interfaces
No
Yes
Look in static routes table, for peer Next Hop in the subnet of one of the router interfaces
No
Yes
Find a router interface in the default gateway subnet
Select as the router interface in use

Figure 3-1. Selecting the Active Router Interface for an Ethernet Flow Serving a Pseudowire

Configuring the General Router Parameters

➤ **To configure the router parameters:**

1. Navigate to the **Configuration > Applications** screen.
2. Select the **Router** option.

Table 3-4 describes the router parameters.

Table 3-4. Router Parameters

Parameter	Function	Values
Interface	Displays the router interface configuration screen	See *Table 3-5* below
Static Route	Displays the static route configuration screen	See *Table 3-6* below
Default Gateway	Specifies the default gateway IP address (usually an IP router port) to which the router will send packets when other routing criteria are not met (see *Figure 3-1*). The default value, **0.0.0.0**, means that no default gateway is defined	Type the desired IP address, using the dotted-quad format. Make sure that the IP address is within the subnet of one of the router interfaces. **Default: 0.0.0.0**
ARP Aging Time (sec)	Selects the aging time for ARP entries. If the ARP entry for a given destination is not refreshed before the specified interval expires, that information is deleted from the ARP table	The allowed range is 300 to 1000000 sec, in 16-sec increments. If the entered value is not a multiple of 16, the nearest multiple of 16 not exceeding your entry, is actually used. **Default: 1200 (20 minutes)**

Configuring Router Interfaces

You can configure a total of 100 router interfaces within the Megaplex-4100, but not more than 6 interfaces per MPW-1 module.

➤ **To configure router interfaces:**

1. Navigate to the **Configuration > Applications > Router** screen, and then select **Interface**.
2. Select the desired interface index:
   - To modify an existing interface, enter its number in the **Number** field, or scroll using **F** and **B**
   - To define a new interface, select **Add**. The new interface is automatically assigned the next free number, in the range of 1 to 100.
3. To delete unnecessary interfaces, select **Delete** (you will be requested to confirm).

Table 3-5 describes the router interface parameters.

Table 3-5. Router Interface Parameters

Parameter	Function	Values
Number	Specifies the index number representing the router interface	The allowed range is 1 to 100. **Default: 1**

Parameter	Function	Values
Name	Used to define a logistic name for this interface	Up to 32 alphanumeric characters. **Default:** When you add a new router interface, it is automatically assigned a default name comprising the string **RI#** and the router interface index number, for example, **RI#1** for the interface with index number 1
IP Address	Specifies the source IP address of the corresponding IP interface	Type the desired IP address, using the dotted-quad format (four groups of digits in the range of 0 through 255, separated by periods). **Default: 0.0.0.0**
IP Mask	Specifies the the IP subnet mask of the corresponding IP interface	Type the desired IP subnet mask, using the dotted-quad format. Make sure to select a subnet mask compatible with the selected IP address, and whose binary representation consists of consecutive "ones", followed by the desired number of consecutive "zeroes". **Default: 0.0.0.0**
Slot	Selects the slot on which the selected router interface is located	The allowed range is I/O-1 to I/O-10, CL-A and CL-B. Only slots with active Ethernet interfaces can be selected. **Default: CL-A**
Port	Selects the port on which the selected exit interface, used to connect to the transport network, is located	The allowed port types include Ethernet ports (**ETH** or **GbE**), and logically concatenated groups (**VCG**), as available on the selected slot: • For I/O modules with several Ethernet ports (for example, M8E1, M8T1, M8SL, OP-108C, OP-106C, MPW-1), you can select a specific ETH port (**ETH-1**, **ETH-2** or **ETH-3**). • For CL.1/GbE modules, you can select **GbE-1**, and **GbE-2**. • For CL.1/155GbE modules, you can select **GbE-1**, **GbE-2**, and **VCG**1 to **VCG8**. **Default: GbE-1**
VLAN Tagging	Controls the use of VLAN tagging for the traffic generated by this router interface. Using a VLAN tag enables differentiating the traffic carried by this router interface. This parameter is not displayed when the selected exit port is a GbE port, or a VCG: in this case, VLAN tagging is always enabled	**ENABLE** – VLAN tagging is enabled (a VLAN tag is inserted in the transmitted packets). **DISABLE** – VLAN tagging is disabled. **Default: DISABLE**

Parameter	Function	Values
VLAN ID	Specifies the VLAN ID inserted in the packets transmitted through this router interface. Using the MEF (Metropolitan Ethernet Forum) terms, this VLAN ID indicates the C-VLAN (customer's edge VLAN). This parameter is displayed only when **VLAN Tagging** is **ENABLE**	The allowed range is **1** to **4094**. The selected VLAN ID must be unique per router interface, but can be reused on different interfaces. **0** means that no VLAN ID has been selected. **Default: 1**

Configuring Static Routes

You can configure up to 100 static routes in the whole Megaplex-4100.

➤ **To configure the static route parameters:**

1. Navigate to the **Configuration > Applications** screen.
2. Select **Router**, and then select **Static Route**.
3. Select the desired static route index:
   - To modify an existing static route, enter its number in the **Number** field, or scroll using **F** and **B**
   - To define a new static route, select **Add**. The new static route is automatically assigned the next free number, in the range of 1 to 100.
4. To delete unnecessary static routes, select **Delete** (you will be requested to confirm).

Table 3-6 describes the static route parameters.

Table 3-6. Static Route Parameters

Parameter	Function	Values
Number	Specifies the index number representing the static route	The allowed range is 1 to 100. **Default: 1**
IP Address	Specifies the IP address of the static route	Type the desired IP address, using the dotted-quad format (four groups of digits in the range of 0 through 255, separated by periods). **Default: 0.0.0.0**
IP Mask	Specifies the IP subnet mask of the static route	Type the desired IP subnet mask, using the dotted-quad format. Make sure to select a subnet mask compatible with the selected IP address, and whose binary representation consists of consecutive "ones", followed by the desired number of consecutive "zeroes". **Default: 0.0.0.0**

Parameter	Function	Values
Next Hop	Specifies an IP address to which the packets will be sent, to enable reaching the destination IP address. This is usually the address of an IP router port	Type in the next hop IP address using the dotted-quad format. To use the default gateway, leave this field at the default value, **0.0.0.0**. **Default: 0.0.0.0**

Configuring the Pseudowire Peers

The peers (the pseudowire destinations) and the associated routing information are defined in a table that can include up to 100 destinations.

Each peer (destination) is assigned a unique index number. The index number is then used to specify the pseudowire destination, instead of directly providing the necessary destination information.

Note

- *Pseudowires configured on different MPW-1 modules must be configured with different peers, even if the destination address is the same.*
- *Different peers must not have the same destination IP address **and** the same Next Hop IP address (at least one of these parameters must be different). Therefore, if it necessary for several pseudowires to reach the same IP address, create separate router interfaces.*

➤ **To configure peers parameters:**

1. Navigate to the **Configuration > Applications > Router** screen.
2. Select the **Peers** option.
3. Select the desired peer index:
   - To modify an existing peer, enter its number in the **Peer Number** field, or scroll using **F** and **B**
   - To define a new peer, select **Add**. The new peer is automatically assigned the next free number, in the range of 1 to 100.
4. To delete unnecessary peers, select **Delete** (you will be requested to confirm).

Table 3-7 lists the peer parameters.

Table 3-7. Peer Parameters

Parameter	Function	Values
Peer Number	Specifies the index number representing the peer	The allowed range is 1 to 100. **Default: 1**
Name	Used to define a logistic name for this peer	Up to 32 alphanumeric characters.. **Default:** When you add a new peer, it is automatically assigned a default name comprising the string **Peer** and the peer index number, for example, **Peer-1** for the peer with index number 1

Parameter	Function	Values
Peer IP Address	Specifies the IP address of the peer	Enter the desired IP address in the dotted-quad format. **Default: 0.0.0.0**
Peer Next Hop Address	Specifies the IP address of the next port to which packets directed to the selected peer will be sent. You need to specify a next hop IP address only when the peer IP address is not within the IP subnet of the router interface that will be used to send packets to this peer. The default value, 0.0.0.0, means that no next hop IP address is defined	Enter the desired IP address in the dotted-quad format. **Default: 0.0.0.0**

Pseudowire Parameters Configuration Sequence

The total number of pseudowires that can be defined on a MPW-1 module is as follows:

- For internal DS1 ports using the DS0 cross-connect mode: up to 16 pseudowires per internal DS1 port, for a maximum of 128 pseudowire for each MPW-1 module
- For internal DS1 ports using the DS1 cross-connect mode: a single pseudowire, using the whole bandwidth of internal DS1 port.

Note *The pseudowire bandwidth depends on the type of port connected to the internal DS1 port:*

- *For E1 ports: 32 timeslots when using the **Unframed** mode, or 31 timeslots when using a **Framed** mode*
- *For T1 ports: 24 timeslots (possible only in the **Framed** mode)*

The total number of pseudowires that can be defined on the whole Megaplex-4100 is 640.

The pseudowire configuration sequence includes the following main steps:

1. Preliminary actions: add a new pseudowire and define its logistic data, or select an existing pseudowire to modify its parameters or delete it.
2. Configure the general pseudowire parameters.
3. Configure the PSN parameters.
4. Configure the pseudowire service parameters
5. Configure the pseudowire attachment circuit parameters.

Note *The following sections provide guidelines for performing the required configuration activities, assuming that you are familiar with the Megaplex-4100 and its range of Ethernet services. If necessary, refer to the Megaplex-4100 Installation and Operation Manual for additional details.*

The tasks needed to configure a pseudowire and its associated parameters are started from the **Configuration > Applications > Multi-Service over PSN** menu.

Preliminary Configuration Steps

➤ **To add a new pseudowire on a MPW-1 module:**

1. Navigate to **Configuration > Applications > Multi-Service over PSN**, and then select **PW**.
2. To configure a new pseudowire, select **Add**. The new pseudowire number is automatically assigned the next free index number, in the range of 1 to 640.
3. Assign a logistic name to the pseudowire (up to 32 alphanumeric characters).

➤ **To modify or delete an existing pseudowire:**

1. To select an existing pseudowire, enter its index number in the **PW Number** field.

   The pseudowire I/O slot and its logistic name is automatically displayed.
2. You can now modify the pseudowire parameters. Note that the pseudowire type and the I/O slot on which it is processed cannot be changed even if the pseudowire is not in use: these parameters can be configured only when the pseudowire is first created (added). Therefore, to change these pseudowire parameters, first delete the pseudowire, and then create a new one with the desired parameters.
3. To delete an unnecessary pseudowire, select **Delete** (you will be requested to confirm).

Configuring General Pseudowire Parameters

The general pseudowire parameters determine the pseudowire encapsulation mode, and its PSN header structure. Other general pseudowire parameters are the pseudowire destination, OAM support, and some parameters used to fine-tune the payload handling.

➤ **To configure the general pseudowire parameters:**

1. Navigate to the **Configuration > Applications > Multi-Service over PSN > PW** screen of the desired pseudowire.
2. Select **General Parameters**.

   You will see the **General Parameters** screen of the desired pseudowire. The pseudowire index, its I/O slot and the assigned logistic name are automatically displayed at the top of the screen.
3. Obtain the prescribed parameters, and then use *Table 3-8* for parameter descriptions and configuration guidelines.

Table 3-8. General Pseudowire Parameters

Parameter	Function	Values
PW Type	Selects the encapsulation protocol for the selected pseudowire	**TDMoIP CE** – Encapsulation using TDMoPSN circuit emulation, can carry data and voice timeslots, as well as unframed data. **HDLC** – Encapsulation using the HDLCoPSN protocol, for carrying HDLC traffic **CESoPSN** – Encapsulation using the CESoPSN protocol, for carrying framed data streams. **SAToP** – Encapsulation using the SAToPSN protocol, for carrying unframed data streams. **Default: TDMoIP CE**
PSN Type	Selects the type of PSN header for the selected pseudowire	**UDP/IP** – UDP over IP. **MPLS/ETH** – MPLS over Ethernet with standard packet structure. In this case, only TDMoIP Version V2 is used. **Default: UDP/IP**
Peer Number	Specifies the selected pseudowire destination. The destination is specified by indicating the index of the pseudowire peer. Make sure to select one of the peers already defined in accordance with the *Configuring the Pseudowire Peers* section	The available selections are 1 to 100. **Default: 1**
OAM Mode	Controls the use of use OAM connectivity protocol for the selected pseudowire. The RAD proprietary implementation of the OAM connectivity protocol enables detecting loss of communication with the pseudowire destination and taking steps that prevent the resulting flooding. The protocol also enables checking that the destination uses a compatible configuration. The selection must be compatible with the equipment at the far end of the connection. Contact RAD Technical Support Department if you need additional information	**DISABLE** – The use of the OAM connectivity protocol is disabled. **PROPRIETARY** – The use of the OAM connectivity protocol is enabled. This is the recommended selection. This option is available only when you select **V2** for **Payload Format** (part of the pseudowire PSN parameters – see *Table 3-9*). **Default: PROPRIETARY**

Parameter	Function	Values
Out PW Label	**For UDP/IP:** Specifies the UDP source port number used by the pseudowire.	The allowed range is 1 to 8063 **Default: Same as the pseudowire index number**
	For MPLS/ETH: Specifies the outer (tunnel) MPLS label used by the pseudowire	The allowed range is 16 to 1048575. **Default: Pseudowire index number + 15**
In PW Label	**For UDP/IP:** Specifies the UDP destination port number used by the pseudowire.	The allowed range is 1 to 8063 **Default: Same as the pseudowire index number**
	For MPLS/ETH: Specifies the inbound MPLS label used by the pseudowire	The allowed range is 16 to 1048575. **Default: Pseudowire index number + 15**

Configuring Pseudowire PSN Parameters

The pseudowire PSN parameters is used to configure the parameters that are used by the PSN to handle pseudowire traffic.

Some of the parameters depend on the PSN selection made as part of the pseudowire general parameters (see *Table 3-8*). In particular, for UDP/IP networks, the pseudowire label determines the source UDP port of a pseudowire. The method used to assign the source UDP port is as follows (unless explicitly stated otherwise, all the numbers are in hexadecimal notation):

- **For TDMoIP CE pseudowires using packet payload Version V1:**

  During normal operation, the source UDP port is given by:

  UDP Source Port = Pseudowire Label + 1

  This means that during normal operation, the UDP ports numbers are in the range of 0 to 8191 decimal.

  While the pseudowire is in the local fail state, the source UDP port changes to:

  UDP Source Port = Pseudowire Label + 8000

  This means that in the local fail state, the UDP ports numbers are higher than 8000 hexa (32768 decimal).

- **For TDMoIP CE pseudowires using packet payload Version V2:**

  UDP Source Port = Pseudowire Label + 2000

  This means that for TDMoIP CE pseudowires, all the UDP ports numbers are higher than 2000 hexa (8192 decimal). This also applies to HDLCoPSN.

  As you may note, when you send to the same peer (destination IP address) packets using both payload Version V1 and payload Version V2, there is a potential for conflict. For example:

  - When you assign a certain label (for example, **Out PW Label** is set to 100) to a pseudowire using payload Version V1, the source UDP port is 101

- Now, you cannot assign the next label (**Out PW Label** of 101 in this example) to a pseudowire using payload Version V2, because the resulting source UDP port is also 101

So, you must skip (never use) the pseudowire label next to the label assigned to pseudowire payload Version V1, if the next pseudowire uses payload Version V2.

- **For CESoPSN and SAToPSN pseudowires using packet payload Version V2:**

UDP Source Port = Pseudowire Number + C000

This means that all the UDP ports numbers are higher than C000 hexa (49152 decimal).

➤ **To select the pseudowire PSN parameters:**

1. Navigate to the **Configuration > Applications > Multi-Service over PSN > PW** screen of the desired pseudowire.
2. Select **PSN Parameters**.

   You will see the **PSN Parameters** screen of the desired pseudowire. The pseudowire index, its I/O slot and logistic name, and the pseudowire type are automatically displayed at the top of the screen.
3. Obtain the prescribed parameters, and then use *Table 3-9* for parameter descriptions and configuration guidelines.

Table 3-9. Pseudowire PSN Parameters

Parameter	Function	Values
ToS	Specifies the Layer 3 priority assigned to the traffic generated by this pseudowire. For IP networks, this priority is indicated by the IP type-of-service parameter for this pseudowire. The specified value is inserted in the IP TOS field of the pseudowire IP packets. When supported by an IP network, the type-of-service parameter is interpreted, in accordance with RFC791 or RFC2474, as a set of qualitative parameters for the precedence, delay, throughput and delivery reliability to be provided to the IP traffic generated by this pseudowire. These qualitative parameters may be used by each network that transfers the pseudowire IP traffic to select specific values for the actual service parameters of the network, to achieve the desired quality of service You can also specify a Layer 2 priority by means of the **VLAN Priority** field, provided **VLAN Tagging** for the router interface used by this pseudowire is **Enable**. This parameter is relevant only when **PSN Type** is **UDP/IP**	Type in the prescribed number, in the range of **0** to **255**. In accordance with RFC 2474, it is recommended to use only values which are multiples of 4. **Default: 0**
Ingress Tunnel Tagging	Controls the use of an interworking MPLS label for the receive (inbound) direction of the pseudowire. Configuring an inbound label for each pseudowire is mandatory. When no outbound label is configured, the inbound label is also used as the outbound label. This parameter is relevant only when **PSN Type** is **MPLS/ETH**	**ENABLE** – Inbound tagging is enabled. **DISABLE** – Inbound tagging is disabled. **Default: DISABLE**

Parameter	Function	Values
Ingress Tunnel Label	Specifies the inbound MPLS label used for the pseudowire. The parameter is displayed only when **Inbound Label Tagging** is **ENABLE**. This parameter is relevant only when **PSN Type** is **MPLS/ETH**	The supported range is **16** to **1048575**. Each pseudowire must have a unique inbound MPLS label. **0** means that no label has been defined. **Default: 0**
Egress Tunnel Tagging	Controls the use of an interworking MPLS label for the transmit (outbound) direction of the pseudowire. This parameter is relevant only when **PSN Type** is **MPLS/ETH**	**ENABLE** – Outbound tagging is enabled. **DISABLE** – Outbound tagging is disabled. **Default: DISABLE**
Egress Tunnel Label	Specifies the outbound MPLS label used for the pseudowire. The parameter is displayed only when **Outbound Label Tagging** is **ENABLE**. This parameter is relevant only when **PSN Type** is **MPLS/ETH**	The supported range is **16** to **1048575**. **0** means that no label has been defined. **Default: 0**
EXP Bits	Specifies the value of the outbound EXP bits that indicate the requested quality of service in the MPLS header of the pseudowire. This parameter is relevant only when **PSN Type** is **MPLS**	The allowed range is is **7** (highest priority) to **0** (lowest priority). **Default: 0**
VLAN Priority	When **VLAN Tagging** is enabled for the router interface used by this pseudowire, specifies the Layer 2 priority assigned to the pseudowire traffic using the selected VLAN. When VLAN tagging is disabled, this parameter is not relevant	The allowed range in accordance with IEEE 802.1p is **7** (highest priority) to **0** (lowest priority). **Default: 0**
Payload Format	Selects the packet payload format. The selection must be compatible with the equipment at the far end of the connection. Contact RAD Technical Support Department if you need additional information	**V1** – Old packet payload format, defined as *experimental* in the relevant IETF drafts, can only be used for TDMoIP CE pseudowires. Not recommended for use. Packet payload version V1 requires two UDP sockets per pseudowire, whereas TDMoIP V2 requires a single UDP socket per pseudowire. **V2** – Current packet payload format. Requires one UDP socket per pseudowire. **Default: V2**

Configuring Pseudowire Service Parameters, and Attachment Circuit Parameters

The pseudowire service parameters include two groups of parameters:

- Pseudowire parameters
- Attachment circuit parameters (that is, the parameters controlling the connection of the pseudowire to the internal DS1 port)

➤ **To configure the pseudowire service parameters:**

1. Navigate to the **Configuration > Applications > Multi-Service over PSN > PW** screen of the desired pseudowire.
2. Select **Service Parameters**.

   You will see the **Service Parameters** screen of the desired pseudowire. The pseudowire index, its I/O slot, the assigned logistic name, and the pseudowire and PSN types are automatically displayed at the top of the screen.
3. Obtain the prescribed parameters, and then use *Table 3-10* for parameter descriptions and configuration guidelines.

➤ **To configure the pseudowire service parameters:**

1. After configuring the pseudowire service parameters, configure the parameters of the attachment circuit that is served by the pseudowire, using *Table 3-11* for parameter descriptions and configuration guidelines.

Table 3-10. Pseudowire Service Parameters

Parameter	Function	Values
TDM Bytes in Frame	Specifies the number of TDM payload bytes to be inserted in each packet. A larger value increases the bandwidth utilization efficiency, but also increases the connection intrinsic latency, in particular when the pseudowire is configured to carry a small number of timeslots	The number is specified as a multiple of 48 bytes, for example, **1** means 48 bytes, and **30** means 1440 bytes. The available selections for TDMoIP are **1** to **30** (48 to 1440 bytes, respectively), and the values for CESoPSN are 4 to 360. **Default: 1**
Payload Size	For TDMoIP and CESoPSN pseudowires: Displays the resulting TDM payload size in bytes, and considering the selected **TDM Bytes in Frame** value. For SAToPSN pseudowires: Specifies the payload size in terms of TDM bytes in the packet. This parameter is not relevant for HDLCoPSN pseudowires	The range is 4 to 1440. For CESoPSN, the number of bytes is determined by the **Payload Size (Frames in Packet)** parameter, multiplied by the number of timeslots assigned to the corresponding pseudowire.

Parameter	Function	Values
Jitter Buffer	Specifies the value of the jitter buffer to be used on this pseudowire. You should use the shortest feasible buffer, to minimize connection latency. This parameter is not displayed for HDLCoPSN pseudowires	The allowed range depends on the framing mode: **FRAMED**: 2500 to 200000 µsec, in 1-µsec steps. **UNFRAMED**: 500 to 200000 µsec, in 1-µsec steps. **Default: 2500**
Far End Type	Specifies the type of framing used by the equipment at the destination endpoint. The selected value also determines the encoding law used on PCM voice channels. Make sure to select the same value at both end points. The selected value must also match the **Line Type** configured for the physical port of the pseudowire local endpoint (see the *Configuring Internal DS1 Port Timeslot Utilization* section) This parameter is not displayed for HDLCoPSN pseudowires	**E1** – E1 stream with G.704 framing. The PCM signals are processed assuming that they are encoded in accordance with the A-law. You can use this selection when the port **Line Type** is a framed version. **T1 ESF** – T1 stream with ESF framing. The PCM signals are processed assuming that they are encoded in accordance with the µ-law. You can use this selection when the port **Line Type** is a framed version. **T1 SF –** T1 stream with SF (D4) framing. The PCM signals are processed assuming that they are encoded in accordance with the µ-law. You can use this selection when the port **Line Type** is a framed version. **UNFRAMED –** unframed data stream, transparently transferred. You can use this selection when the port **Line Type** is **UNFRAMED**. This is the only selection for SAToPSN pseudowires, but it is not allowed for CESoPSN pseudowires. **Default: E1**
Sensitivity	Used to select the optimum parameters for the clock recovery mechanism of the selected pseudowire. This parameter is not displayed for HDLCoPSN pseudowires	**DATA –** Performance is optimized for accurate clock recovery. This selection is optimal for data transmission applications. **DELAY –** Performance is optimized for constant delay. This selection is optimal for voice transmission applications. **Default: DATA**
Voice OOS	Selects the code transmitted during out-of-service periods on the timeslots defined as voice timeslots (see the *Configuring Internal DS1 Port Timeslot Utilization* section). This parameter is not displayed for HDLCoPSN pseudowires, also when the port uses the **UNFRAMED** mode	The available selections are 00 to FF (hexa). **Default: 00**

Parameter	Function	Values
Data OOS	Selects the code transmitted by the port during out-of-service periods on the timeslots defined as data timeslots (see the *Configuring Internal DS1 Port Timeslot Utilization* section). The selected code is also sent during out-of-service periods instead of the external data stream when the **UNFRAMED** mode is used	The available selections are 00 to FF (hexa). **Default: 00**
OOS Signaling	Determines the state of the signaling bits sent to the internal DS1 port connected to the selected pseudowire during out-of-service periods. This parameter is displayed only when the attached internal DS1 port is configured with **Signaling = YES**	**FORCED IDLE** – The signaling bits are forced to the idle state (05 hexa) during out-of-service periods. **FORCED BUSY** – The signaling bits are forced to the busy state (0F hexa) during out-of-service periods. **Default: FORCED IDLE**
Attachment Circuit	Opens the pseudowire attachment circuit parameters screen	See *Table 3-11*

Table 3-11. Pseudowire Attachment Circuit Parameters

Parameter	Function	Values
Slot	Selects the I/O slot number on which the pseudowire will be terminated. You can select only I/O slots in which MPW-1 modules are programmed	IO-1 to IO-10. **Default: IO-1**
Int DS1 Number	Selects the internal DS1 port of the selected MPW-1 to which the pseudowire is connected	The allowed range is 1 to 8. **Default: 1**
Time Slots	Displays the timeslot assignment submenu for this pseudowire. This item is displayed only when the internal DS1 port uses the DS0 cross-connect mode	See below

Selecting Internal DS1 Timeslots Connected to a Pseudowire

The internal DS1 ports provide a connection point between TDM traffic arriving from other modules and the pseudowires supported by MPW-1 (see the *Configuring Internal DS1 Port Timeslot Utilization* section starting on page *3-11*). Each pseudowire can be connected to only one internal DS1 port.

When the internal DS1 port to which the pseudowire uses the DS0 cross-connect mode, you must specify the timeslots to be served by the pseudowire.

➤ **To select the timeslots connected to the pseudowire:**

1. Navigate to the **Configuration > Applications > Multi-Service over PSN > PW > Service Parameters** screen of the desired pseudowire.
2. After selecting the prescribed internal DS1 port, select **Time Slots**.
3. Initially, the screen is empty. Select **Add** to add the desired number of timeslot selection fields.
4. Sequentially select each timeslot selection field, and enter the number of the prescribed timeslot.
5. When done, save the selections by typing **s**.
6. The selected timeslots are listed now in a single row, and a new item, **Delete Range**, appears. This item enables to delete the current selections: type the desired numbers in the format displayed on the screen and then confirm.

Configuring Fault Propagation for MPW-1 Modules

The fault propagation function can be used to notify equipment at a far end port that a fault condition has been detected at a local port.

MPW-1 modules support unidirectional fault propagation for pseudowires: if a problem is detected on a pseudowire, the attached physical port receives a fault indication.

Fault propagation cannot be enabled for ports with redundancy enabled.

For the supervision terminal, use **Configuration > System > Fault Propagation** (for instructions, refer to the *Megaplex-4100 Installation and Operation Manual*).

➤ **To configure fault propagation:**

1. On the **Configuration > System** menu, select **Fault Propagation**, and then press **<Enter>**.
2. Select **Fault Propagation** to toggle the selection: to configure fault propagation, select **ENABLE**.
3. Select **Interfaces** to display the interface configuration screen. If no interfaces has yet been mapped for fault propagation, the screen is empty.
4. To add fault propagation between a new pair of interfaces, type **A** (**Add**) and then press **<Enter>**.

   You will see the **Interface** configuration data form.
5. Select the first endpoint, **Slot A**: you will see a submenu which lists I/O slots in which modules with ports that support fault propagation are installed, or at least programmed. For pseudowires, select **None**.
6. Select the desired pseudowire index number for **Slot A**.
7. After selecting the desired pseudowire, repeat the selections for the physical endpoint (**Slot B** and **Port B**) of the pseudowire.
8. After specifying the two endpoints, select the fault propagation direction by means of the **Mode** field. The only selection valid for pseudowires is **UniDirectional(A- > B**): fault conditions are reported only from endpoint A (the selected pseudowire) to endpoint B.

9. Type **s** to save the configuration.
10. After completing the configuration, the new set of endpoints appear on the **Interfaces** screen.
11. Repeat the procedure for any additional endpoints.

3.5 Configuring Pseudowires as System Timing References

MPW-1 has independent adaptive clock recovery mechanisms for each pseudowire, which recover the original timing (clock rate) of the far end source of each pseudowire.

The recovered mechanisms can provide the recovered clock signals to serve as timing references for the Megaplex-4100 nodal timing subsystem (refer to the *Megaplex-4100 Installation and Operation Manual* for a description of this subsystem).

To select pseudowires as timing reference, first select the appropriate pseudowires of the desired MPW-1 modules, and then include them in the master and/or fallback list of clock sources.

You can select up to 10 pseudowires as master clock sources, and up to 10 additional pseudowires as fallback sources, for a total of 20 pseudowires per Megaplex-4100. Any pseudowire can be included only once, either as master or as fallback source.

You cannot select HDLCoPSN pseudowires as clock sources.

➤ **To configure the recovered clock sources that can be used as timing references:**

1. Navigate to **Configuration > System > Clock Source**.
2. Select **Recovered**.

Table 3-12 describes the recovered clock source parameters.

Table 3-12. Recovered Clock Source Parameters

Parameter	Function	Values
Slot	Displays the slot of the selected pseudowire	The allowed range is I/O-1 to I/O-10. **Default: I/O-1**
Type	Displays the clock source type	Always **ADAPTIVE**
ID	Specifies the index number of the recovered clock source to be configured	The allowed range is 1 to 20. **Default: 1**
PW Number	Specifies the pseudowire index number that will be the source with the selected index number	The allowed range is 1 to 640. 1 – number of allowed pseudowire per device. **Default:** the first index number of an existing pseudowire

Parameter	Function	Values
Administrative Status	Controls whether the selected recovered clock source is active or not	**UP** — Adaptive clock recovery is enabled. **DOWN** — Adaptive clock recovery is disabled. This state should be selected as long as the source configuration has not yet been completed, or when it is necessary to stop using this clock source. **Default: DOWN**
Source Quality	Specifies the quality of the original timing source, using the standard SDH/SONET terminology. You should not select **Stratum 1** and **Stratum 2**. Contact RAD Marketing Department for details	The available selections are **STRATUM 1**, **STRATUM 2**, **STRATUM 3**, **STRATUM 3E**, or **STRATUM 4**. **Default: STRATUM 4**
Network Type	Specifies the type of packet switched network used to transport the pseudowire	**Type A** – Switch-based network, for example, an MPLS/ETH network. **Type B** – Router-based network, for example, an UDP/IP network. **Default: Type B**

➤ **To select a pseudowire as timing reference:**

1. To start the nodal timing configuration, navigate to **Configuration › System › Clock Source** and then select **Source**.
2. Make sure that **Rx Clock** is selected: if not, select this option.
3. After making your selection, the **Clock Source** screen changes to enable selecting master and fallback sources.
4. Select **Master Port** to start the selection of the master timing sources.
5. For each source:
   1. To select a physical port, first select **RX Clock** in the **Type** column, and then specify the desired slot and port.

      The list includes only slots in which modules with ports capable of providing a timing reference are installed and/or programmed.
   2. To use pseudowires, first select **Recovered** in the **Type** column, and then specify the index number of the recovered clock source to be configured (see *Table 3-12*). The **Slot** column displays **None** in the corresponding row.
6. After configuring all the required sources, press **ESC** to return to the **Clock Source** screen.
7. To select pseudowires as fallback sources, select **Fallback Port** and repeat the same actions. Make sure to select different sources: you cannot select again a source already included in the **Master Port** list.

3.6 Viewing Ethernet Flows Associated with Pseudowires

After performing the pseudowire configuration activities listed above, you can view the Ethernet traffic flows that are used by pseudowires.

For the supervision terminal, use **Configuration › Applications › Ethernet Services › Flows** (for instructions, refer to the *Megaplex-4100 Installation and Operation Manual*).

The Ethernet flow of each pseudowire is an E-line flow, and therefore it has exactly two bridge ports:

- One bridge port is the router interface used by corresponding pseudowire
- The other bridge port is the selected exit port:
  - For I/O modules with Ethernet ports (for example, M8E1, M8T1, M8SL, OP-108C, OP-106C, MPW-1): a specific ETH port (**ETH-1**, **ETH-2** or **ETH-3**).
  - For CL.1/GbE modules: the GbE port, **GbE-1** or **GbE-2**.
  - For CL.1/155GbE modules: a GbE port**, GbE-1** or **GbE-2**, or a virtually concatenated group, **VCG**1 to **VCG8**.

Chapter 4

Troubleshooting and Diagnostics

This Chapter explains the MPW-1-specific troubleshooting and diagnostic functions. These functions include:

- Collection of MPW-1 performance monitoring and status data – presented in *Section 4.1*.
- Detection of configuration (sanity) errors – presented in *Section 4.2*. This section covers only the MPW-1 specific sanity errors: for other sanity errors, refer to the *Megaplex-4100 Installation and Operation Manual*.
- Interpretation of alarms – presented in *Section 4.3*. This section covers only the MPW-1 specific alarms: for other alarms, refer to the *Megaplex-4100 Installation and Operation Manual*.
- Troubleshooting instructions: *Section 4.4*.
- Diagnostic tests for checking transmission paths – presented in *Section 4.5*.

The information presented in this Chapter supplements the general Megaplex-4100 troubleshooting and diagnostics instructions contained in the *Megaplex-4100 Installation and Operation Manual*.

If you need additional support for this product, see *Section 4.6* for technical support information.

4.1 Monitoring Performance

This section presents the MPW-1 performance statistics and status data relevant to TDMoIP applications. For other monitoring tasks, refer to the *Megaplex-4100 Installation and Operation Manual*.

When using the Megaplex-4100 supervision utility, the performance monitoring functions are accessed under the **Monitoring** menu.

MPW-1 collects the following types of performance monitoring and status data:

- For MPW-1 Ethernet physical ports:
  - Status data for each Ethernet port, and SFP data when the MPW-1 Ethernet ports are equipped with optical interfaces
  - Transmission performance statistics

  When using the Megaplex-4100 supervision utility, the MPW-1 Ethernet physical port performance monitoring functions are accessed after selecting the desired module under **Monitoring › Physical Layer › I/O › Ethernet**.

- For pseudowires terminated on MPW-1 ports:
  - Status data for each pseudowire
  - Pseudowire transmission statistics

  The MPW-1 pseudowire performance monitoring functions are accessed after selecting the desired pseudowire under **Monitoring > Applications > Multi-Service over PSN > PW**.
- When protection is used for MPW-1 ports, and/or for pseudowire connections terminated on MPW-1 ports: protection status. The protection status is accessed using **Monitoring > Physical > I/O > Int DS1 > Status**.
- When pseudowires are used as system timing sources: display the status of the (adaptive) clock recovery mechanism. The recovered clock status is accessed using **Monitoring > System > Timing.**

The collected data enables the system administrator to monitor the transmission performance, and thus the quality of service provided to users, for statistical purposes. In addition, when problems are reported by users served by MPW-1, the collected data can be used for diagnostic purposes, because it can help identify the source of the problem.

The performance statistics data is continuously collected, and is stored as long as the equipment operates. The stored data is deleted when the MPW-1 is reset or removed, and is also lost when the Megaplex-4100 is powered down.

Monitoring Ethernet Ports

The Ethernet port physical layer performance monitoring data includes:

- Status data for the port.
- Statistics data. Statistics can be displayed only for enabled ports: if the Ethernet port is not enabled, its monitoring display is empty.

➤ **To display status data for an Ethernet port:**

1. Navigate to the **Monitoring > Physical Layer > I/O > Ethernet** screen of the desired module, and select the desired Ethernet port, **ETH 1**, **ETH 2**, or **ETH 3**.
2. On the Ethernet port screen, select **Status**. The Ethernet port status parameters are explained in *Table 4-1*.
3. For an Ethernet port with optical interface, you can also display information and status data for the SFP serving the port: select **SFP Status** on the corresponding Ethernet port **Status** screen. The SFP status parameters are explained in *Table 4-2*.

Note *When no SFP is installed, or the data cannot be read, you will see **Unknown** for the **Connector Type**, and the other fields display zero.*

Table 4-1. Ethernet Port Physical Layer Status Parameters

Parameter	Description
Connector Type	Displays the port connector type: • **RJ-45** – RJ-45 connector for copper interface. • **SFP** – in accordance with the installed SFP. • **Missing** – port equipped with SFP socket, but no SFP is installed.
Operation Status	Displays the Ethernet port status: • **Up** – the port is connected to a LAN and operating normally • **Down** – the port does not carry traffic, e.g., it is not connected to an active LAN
Auto Negotiation	Displays the auto-negotiation status: • **Completed** – the port completed the negotiation process and the operating rate and mode has been selected • **Negotiating** – the port uses auto-negotiation, and is currently performing the negotiation process needed to select the operating rate and mode • **Disabled** – the port operating rate and mode is manually selected
Speed and Duplex	Displays the port current rate and mode: • **10Mbps half duplex** – Half-duplex operation at 10 Mbps • **10Mbps full duplex** – Full-duplex operation at 10 Mbps • **100Mbps half duplex** – Half-duplex operation at 100 Mbps • **100Mbps full duplex** – Full-duplex operation at 100 Mbps

Table 4-2. SFP Status Parameters

Parameter	Description
Connector Type	Displays the SFP connector type, for example, **LC**, **SC**, **SC/APC, FC**, etc.
Manufacturer Name	Displays the original manufacturer's name
Vendor PN	Displays the original vendor's part number
Typical Max. Range	Displays the maximum range expected to be achieved over typical optical fibers, in kilometers
Wave Length	Displays the nominal operating wavelength of the SFP, in nm
Fiber Type	Displays the type of optical fiber for which the SFP is optimized: single mode or multi mode
TX Power (dBm)	Displays the current optical power, in dBm, transmitted by the SFP
RX Power (dBm)	Displays the current optical power, in dBm, received by the SFP
Laser Bias (mA)	Displays the measured laser bias current, in mA
Laser Temperature	Displays the measured laser temperature, in °C

➤ **To display the Ethernet port performance monitoring statistics:**

1. Navigate to the **Monitoring > Physical Layer > I/O > Ethernet** screen of the desired module, and select the desired Ethernet port, **ETH 1**, **ETH 2**, or **ETH 3**.

2. On the Ethernet port screen, select **Statistics**.

   You will see the **Statistics** screen for the selected Ethernet port. The screen consists of three pages:

   - To continue to the next page, type **n** (next)
   - To return to the previous page, type **p** (previous).

Table 4-3 explains the Ethernet port statistics parameters.

The information is accumulated continuously while the MPW-1 operates, and is automatically refreshed every few seconds. You can clear the displayed statistics (that is, reset the displayed performance monitoring counters) by typing **C**. The counters are also reset when the MPW-1 is powered up.

Table 4-3. Ethernet Port Physical Layer Performance Monitoring Statistics

Parameter	Description
Rx Total Frames	Total number of frames received through the corresponding Ethernet port
Rx Total Octets	Total number of data octets carried by all frames received through the corresponding Ethernet port
Rx Correct Frames	Total number of good frames received through the corresponding Ethernet port
Rx FCS Errors	Total number of frames received by the corresponding Ethernet port which has an invalid FCS, but met the following conditions: • Frame data length is between 64 bytes, and 1518 or 1536 bytes (depending on mode) • Collision event has not been detected • Late collision event has not been detected
Rx Jabber Errors	Total number of frames received by the corresponding Ethernet port during jabber (such frames are frames with a data field length exceeding 1518 or 1536 bytes, and also having invalid CRC)
Rx Fragments Errors	Number of fragmented frames received at the corresponding Ethernet port (a fragmented frame is a frame with a data field length less than 64 bytes and invalid CRC, for which no collision event and no late collision event have not been detected during its reception)
Rx Pause Frames	Total number of **pause** frames (used for flow control) received through the corresponding Ethernet port
Rx Undersized Frames	Total number of frames with size less than 64 bytes received through the corresponding Ethernet port
Rx Oversized Frames	Total number of frames with size more than the maximum allowed received through the corresponding Ethernet port
Rx Discard Frames	Total number of valid frames received by the corresponding Ethernet port that have been discarded because of a lack of buffer space. This includes frames discarded at ingress, as well as those dropped due to priority and congestion considerations at the output queues
Rx Errors	Total number of frames received by the corresponding Ethernet port that had other types of errors

Parameter	Description
Rx Unicast Frames	Total number of good unicast frames received through the corresponding Ethernet port
Rx Multicast Frames	Total number of good multicast frames received through the corresponding Ethernet port
Rx Broadcast Frames	Total number of good broadcast frames received through the corresponding Ethernet port
Rx 64 Octets	Total number of 64-byte frames received through the corresponding Ethernet port
Rx 65-127 Octets	Total number of frames with size of 65 to 127 bytes received through the corresponding Ethernet port
Rx 128-255 Octets	Total number of frames with size of 128 to 255 bytes received through the corresponding Ethernet port
Rx 256-511 Octets	Total number of frames with size of 256 to 511 bytes received through the corresponding Ethernet port
Rx 512-1023 Octets	Total number of frames with size of 512 to 1023 bytes received through the corresponding Ethernet port
Rx 1024-long Octets	Total number of frames with size of 1024 up to 1600 bytes received through the corresponding Ethernet port
Tx Total Frames	Total number of good frames transmitted by the corresponding Ethernet port
Tx Total Octets	Total number of data octets carried by all the good frames transmitted by the corresponding Ethernet port
Tx Correct Frames	Total number good frames transmitted by the corresponding Ethernet port
Tx Collisions	Total number of collisions detected at the corresponding Ethernet port
Tx Unicast Frames	Total number of good unicast frames transmitted by the corresponding Ethernet port
Tx Multicast Frames	Total number of good multicast frames transmitted by the corresponding Ethernet port
Tx Broadcast Frames	Total number of good broadcast frames transmitted by the corresponding Ethernet port

Monitoring Pseudowire Services

The pseudowire services monitoring functions include:

- Status data for each pseudowire terminated on MPW-1 ports
- Diagnostic statistics for the current 15-minute interval (interval 0), any previous 15-minute interval within the last 24 hours for which valid performance data exists, and data for the current 24-hour interval.
- Transmission performance statistics.

The statistics data is continuously collected, and is stored as long as the equipment operates. The stored data is deleted when the MPW-1 is reset or removed, and is also lost when the Megaplex-4100 is powered down.

You can clear the displayed statistics (that is, reset the monitoring counters) by typing **C**. The counters are also reset when the MPW-1 is powered up.

The collected data enables the system administrator to monitor the pseudowire performance, and thus the quality of service provided to users, for statistical purposes. In addition, when problems are reported by users served by MPW-1, the collected data can be used for diagnostic purposes, because it can help identify the source of the problem.

Displaying Pseudowire Status Data

➤ **To display status data for pseudowires:**

1. Navigate to **Monitoring > Applications > Multi-Service over PSN > PW** screen, and select **Status**.
2. The **Status** screen displays the status data for the first pseudowire. To select another pseudowire you can either specify its index number, in the range of 1 to 640, or sequentially scroll forward or backward by typing **F** or **B**. Unused index numbers are automatically skipped.
3. After selecting a pseudowire, the information displayed on the screen is updated to display its status.

Table 4-4 explains the pseudowire status parameters.

Table 4-4. Pseudowire Status Parameters

Parameter	Description
PW Number	Used to select the pseudowire with the desired index number. Megaplex-4100 supports up to 640 pseudowires (the maximum number per MPW-1 is 128)
PW Slot	Displays the I/O slot number, I/O-1 to I/O-10, of the MPW-1 module which terminates the selected pseudowire
Name	Displays the logistic name assigned to the selected pseudowire. An empty string means that no name has been assigned to the selected pseudowire

Parameter	Description
PW Type	Displays the pseudowire type (protocol): **TDMoIP CE** – Pseudowire using TDMoPSN circuit emulation. **HDLC** – Pseudowire using the HDLCoPSN protocol **CESoPSN** – Pseudowire using the CESoPSN protocol **SAToP** – Pseudowire using the SAToPSN protocol
Peer IP Address	Displays the pseudowire destination IP address (the peer IP address)
Next Hop MAC Address	Displays the MAC address of the next port on the path to the destination (the next hop MAC address)
Connectivity Status	Displays the connectivity status of the selected pseudowire: **OK** – the pseudowire carries traffic, and both the remote and the local pseudowire endpoints receive Ethernet frames. However, there may be problems such as sequence errors, underflows, overflows, etc., which may be displayed using the **Statistics** function. **LOCAL FAIL** – a failure has been detected at the local pseudowire endpoint. **REMOTE FAIL** – a failure is reported by the remote pseudowire endpoint. **UNAVAILABLE** – the pseudowire reports loss of connectivity (it did not receive neither OAM, nor data packets for 10 seconds or more (OAM link then reports loss of synchronization). This is often caused by network problems, or configuration errors. **VALIDATION FAIL** – the remote pseudowire endpoint replied to OAM packets, but there is a configuration mismatch (the configuration parameters used at two endpoints of the pseudowire are different)

Displaying Pseudowire Diagnostic Statistics

You can display, for each pseudowire, the desired diagnostic statistics view:

- Current 15-minute interval (interval 0)
- Any previous 15-minute interval within the last 24 hours, for which valid performance data exists
- Total for the current 24-hour interval.

➤ **To display diagnostic statistics data for pseudowires:**

1. Navigate to **Monitoring > Applications > Multi-Service over PSN > PW** screen, and select **Statistics**.
2. On the **Statistics** screen, select **Intervals**.
3. The **Intervals** screen displays the number of the first pseudowire, the number of the I/O slot on which it is terminated, and an interval selection menu. To select another pseudowire you can either specify its index number, in the range of 1 to 640, or sequentially scroll forward or backward by typing **F** or **B**. Unused index numbers are automatically skipped.
4. Select the desired display view:
    1. To display statistics for the current 15-minute interval, select **Current (15 min)**.

2. To display statistics for a selected previous 15-minute interval, select **Select Interval**.
3. To display the total statistics for the current 24-hour interval, select **Total (24 hours)**.

You can clear the displayed statistics (that is, reset the monitoring counters) by typing **C**: all the counters are simultaneously reset. The counters are also reset when the MPW-1 is powered up.

Table 4-5 explains the pseudowire diagnostic (interval) statistics parameters.

Table 4-5. Pseudowire Diagnostic (Interval) Statistics Parameters

Parameter	Description
PW Number	Used to select the pseudowire with the desired index number. Megaplex-4100 supports up to 640 pseudowires (the maximum number per MPW-1 is 128)
Slot	Displays the I/O slot number, I/O-1 to I/O-10, of the MPW-1 module which terminates the selected pseudowire
Name	Displays the logistic name assigned to the selected pseudowire. An empty string means that no name has been assigned to the selected pseudowire
Interval Number	After selecting **Select Interval**, enter the number of the desired 15-minute interval whose statistics you wish to display. The allowed range is 1 to 96. The actual maximum depends on the number of intervals for which valid data is available, which is displayed by the **Valid Intervals**.
Sequence Errors Seconds	Displays the number of seconds during which sequence errors have been detected. In accordance with the applicable standards, the transmitted packets carry a sequence number that is automatically assigned, such that consecutive packets are automatically consecutive sequence numbers. At the receive side, these numbers are checked by the receive mechanism, which expects each new incoming packet to carry the next number in the sequence, relative to the previous one (i.e., packet 5 must be received after packet 4). Any deviation from the this rule indicates a problem with packet flow integrity (and hence with the pseudowire payload (data or voice) integrity), and in this case the sequence errors count is incremented by 1. There are two main reasons for a sequence error event: • One or more packets have been lost somewhere in the network. • Packets have been reordered within the network. Packet reordering may occur due to queuing mechanisms, rerouting by the network, or when the router updates include very large routing tables

Parameter	Description
Jitter Buffer Underflows Seconds	Displays the number of seconds during which at least one jitter buffer underflow event has been detected. MPW-1 is equipped with a Packet Delay Variation Tolerance buffer, also called a "jitter buffer", which is used to automatically compensate for packet network delay variation (jitter). Each pseudowire has its own jitter buffer. Although packets leave the transmitting MPW-1 at a constant rate, they will usually reach the far end at a rate which is not constant, because in practice the network transmission delay varies (due to factors such as congestion, rerouting, queuing mechanisms, transport over wireless or half-duplex media, etc.). TDM equipment at both ends of a pseudowire require a constant flow of data, and cannot tolerate delay variation. Therefore, the receive side jitter buffer is required to provide the TDM equipment with a synchronous and constant flow. For this purpose, when a pseudowire is set up (and at any time after communication is restored), the jitter buffer is loaded with packets up to its middle point: only after this point it starts outputting TDM data towards the connected TDM equipment. The stored packets assure that the TDM equipment will continue receiving data even if the network delay momentarily increases. Obviously, if packets are delayed too long, the buffer is gradually emptied out until it underflows (this situation is called buffer starvation, and it affects the end-to-end voice/data integrity). Each underflow event increases the jitter buffer underflow counter by 1.
Jitter Buffer Overflows Seconds	Displays the number of seconds during which at least one jitter buffer overflow event has been detected. As explained above, during steady state, the jitter buffer is filled up to its middle point, which means that it has space to hold additional packets. An overflow will occur when the network delay suddenly decreases, for example, when a large burst of packets reaches the MPW-1. If the burst includes more packets than the jitter buffer can store at that instant, the buffer will be filled up to its top. In this case, an unknown number of excess packets are dropped. To correct the situation, MPW-1 initiates a forced underflow by flushing (emptying) the buffer. Therefore, an overflow always results in an immediate underflow. After the buffer is flushed, the process of filling up the buffer is started again
Min Jitter Buffer Level (usec)	Actual minimum size of the jitter buffer recorded for this pseudowire in the selected interval, in µsec
Max Jitter Buffer Level (usec)	Actual maximum size of the jitter buffer recorded for this pseudowire in the selected interval, in µsec
Max Jitter Buffer Deviation (usec)	The maximum jitter buffer deviation (variation of delay, in µsec) reported during the selected interval. This is the maximum jitter level that had to be compensated for in the selected interval
Time Elapsed	The elapsed time since the beginning of the current interval (for a selected interval, the displayed time is always 15 minutes), or the elapsed time since the beginning of the curent 24 hour interval
Valid Intervals	The total number of 15-minute intervals for which valid data is available

Displaying Pseudowire Transmission Statistics

The pseudowire transmission statistics enable analyzing pseudowire traffic volume, evaluate the end-to-end transmission quality (as indicated by sequence errors), and jitter buffer performance. By resetting the status data at the desired instant, it is possible to ensure that only current, valid data is taken into consideration.

➤ **To display diagnostic statistics data for pseudowires:**

1. Navigate to **Monitoring > Applications > Multi-Service over PSN > PW** screen, and select **Statistics**.
2. On the **Statistics** screen, select **Counters**.
3. The **Status** screen displays the statistics data for the first pseudowire. To select another pseudowire you can either specify its index number, in the range of 1 to 640, or sequentially scroll forward or backward by typing **F** or **B**. Unused index numbers are automatically skipped.
4. After selecting a pseudowire, the information displayed on the screen is updated to display the accumulated statistics data.

You can clear the displayed statistics (that is, reset the monitoring counters) by typing **C**: all the counters are simultaneously reset. The counters are also reset when the MPW-1 is powered up.

Table 4-6 explains the statistics counters parameters.

Table 4-6. Pseudowire Statistics (Counters) Parameters

Parameter	Description
PW Number	Used to select the pseudowire with the desired index number. Megaplex-4100 supports up to 640 pseudowires (the maximum number per MPW-1 is 128)
Slot	Displays the I/O slot number, I/O-1 to I/O-10, of the MPW-1 module which terminates the selected pseudowire
Name	Displays the logistic name assigned to the selected pseudowire. An empty string means that no name has been assigned to the selected pseudowire

Parameter	Description
Connectivity Status	Displays the connectivity status of the selected pseudowire: **OK** – the pseudowire carries traffic, and both the remote and the local pseudowire endpoints receive Ethernet frames. However, there may be problems such as sequence errors, underflows, overflows, etc., which may be displayed using the **Statistics** function. **LOCAL FAIL** – a failure has been detected at the local pseudowire endpoint. **REMOTE FAIL** – a failure is reported by the remote pseudowire endpoint. **UNAVAILABLE** – the pseudowire reports loss of connectivity (it did not receive neither OAM, nor data packets for 10 seconds or more (OAM link then reports loss of synchronization). This is often caused by network problems, or configuration errors. **VALIDATION FAIL** – the remote pseudowire endpoint replied to OAM packets, but there is a configuration mismatch (the configuration parameters used at two endpoints of the pseudowire are different).
TX Packets	Total number of frames transmitted toward the PSN
RX Packets	Total number of frames received from the PSN
Sequence Errors	Total number of packets that did not arrive in time, as expected according to their sequence number (either because they were lost in the network, or reordered). See also *Table 4-5*
Jitter Buffer Underflows	Total number of jitter buffer underflow events. See also *Table 4-5*
Jitter Buffer Overflows	Total number of jitter buffer overflow events. See also *Table 4-5*

Monitoring Internal DS1 Port Status

When an internal DS1 port of the MPW-1 is included in a redundancy pair, the current redundancy status can be displayed.

➤ **To display the Int DS1 status:**

1. Select **Monitoring > Physical > I/O > I/O 2 (MPW1) > Int-DS1 > Status**.
2. The screen displays the current function of the selected port within the **Int DS1** pair:

Active	The port is the active port (the port carrying the traffic).
Standby	The port is in standby, and does not carry traffic.

Monitoring the Timing Source Status

Megaplex-4100 monitoring function enables displaying information regarding the current MPW-1 timing source (see details in the *Megaplex-4100 Installation and Operation Manual*).

When a pseudowire is used as a Megaplex-4100 timing reference source, the timing source display includes information on the state of the pseudowire adaptive clock recovery mechanism.

➤ **To display the pseudowire adaptive clock recovery mechanism state:**

1. Navigate to **Monitoring > System > Timing**.
2. You will see the **Timing** screen. The information displayed on the screen depends on the currently used timing source. *Table 4-7* explains the information displayed when a pseudowire serves as the reference source.

Table 4-7. Timing Monitoring Parameters

Parameter	Description
Active Clock	Displays the type of timing reference source in use, **Master** of Fallback
Source	Displays the selected nodal timing mode: **Internal** – Timing locked to the MPW-1 internal oscillator **Rx Clock** – Timing locked to the recovered receive clock signal of a user-selectable interface, including a pseudowire configured as timing reference source **S Subsystem** – Timing locked to the clock signal provided by the SDH/SONET subsystem **Recovered** – Timing locked to the recovered receive clock signal of a user-selected pseudowire
Rx Clock	Identifies the timing reference source in use: module type, its I/O slot number, and the specific port. A pseudowire is identified as **Recovered ID#X** (**PW#YYY)**, where **X** is the index number of the pseudowire selected as recovered (adaptive) timing using the **System > Clock Source** screen, and **YYY** is the pseudowire index number
Holdover	Indicates whether the nodal timing subsystem is in the holdover state (**Yes**) or not (**No**). The nodal timing subsystem enters the holdover state when all the configured sources (master and fallback) fail. In the holdover mode, the maintains the internal reference frequency at the last value acquired before the failure. This situation persists until at least one of the configured reference source returns to normal, and thus is selected again as reference
Recovered Clock Status	Displays the current status of the pseudowire adaptive clock recovey mechanism: **Free Run**: indicates that the clock recovery mechanism is not locked to any clock. **Frequency Acquisition**: indicates that the clock recovery mechanism is learning the frequency of the selected reference. **Rapid Phase Lock**: indicates that the clock recovery mechanism is in the training process. **Fine Phase Lock**: indicates that the clock recovery mechanism successfully completed the training process., and is now locked. At this stage, the clock recovery mechanism provides a stable clock of good quality. **-----** : the adaptive clock recovery status is not relevant.

4.2 Detecting Configuration Errors

Table 4-8 lists the specific configuration error messages that may generated by Megaplex-4100 for MPW-1 modules, and explains their interpretation. The messages are listed in ascending order of their codes.

For other sanity errors, refer to the *Megaplex-4100 Installation and Operation Manual*.

Table 4-8. MPW-1 Specific Error Messages

Code	Syntax	Type	Meaning
2100	SAME IP FOR ROUTER IFACE & D.GATEWAY	Error	The same IP address has been defined for both the default gateway and for one of the router interfaces. This is not allowed. Note however that this error may also appear because the default IP addresses (0.0.0.0) have not yet been changed
2101	ROUTER IFACE IP&GTWAY NOT SAME SUBNET	Error	At least one of the IP addresses assigned to router interfaces must be in the IP subnet of the MPW-1 router default gateway
2103	OUT PW LABEL IS NOT UNIQUE	Error	This message, which is generated only after the specified pseudowire is created, indicates that two or more pseudowires directed to a given destination IP address have the same source UDP port number (the check is made irrespective of the pseudowire PSN type, UDP/IP or MPLS/ETH). This is not allowed. For UDP/IP PSNs, the UDP port is automatically assigned in accordance with the pseudowire label value, therefore you need to change the pseudowire labels to avoid conflict. The assignment rules are as follows (see *Chapter 3* for parameter descriptions): • When the configured pseudowire **Payload Format** is **V1** (proprietary format), the source UDP port is **Out PW Label + 1** • In all the other cases, the source UDP port value is equal to the configured **Out PW Label** value See also sanity error 2123
2104	IN PW LABEL IS NOT UNIQUE	Error	This message, which is generated only after the specified pseudowire is created, indicates that two or more pseudowires have the same source UDP port number (the check is made irrespective of the pseudowire PSN type, UDP/IP or MPLS/ETH). This is not allowed. See sanity error 2103 for UDP port assignment rules

Code	Syntax	Type	Meaning
2105	IP & NEXT HOP SAME FOR STATIC ROUT	Error	This message is generated after the specified static route is updated, and indicates that the next hop IP address and the destination IP address of the route are the same. This is not allowed – the addresses must be different. If the next hop IP address is not needed, leave the default value, 0.0.0.0. Note however that this error may also appear because the default IP addresses (0.0.0.0) have not yet been changed
2106	STATIC ROUTE IP IS NOT UNIQUE	Error	This message, which is generated only after the specified static route is updated, indicates that the route destination IP address is already used in another static route. This is not allowed – only one static route may be defined for any specific destination IP address. Note however that this error may also appear because the default IP addresses (0.0.0.0) have not yet been changed
2107	ROUTER IFACES CAN'T BE ON SAME SUBNET	Error	The IP addresses assigned to the router interfaces must be in different IP subnets
2108	MORE THAN 16 PWS FOR INTERNAL DS1	Error	You are trying to connect too many pseudowires to the same internal DS1 port (the maximum is 16 pseudowire per port)
2110	ILLEGAL FAR END TYPE CONFIGURATION	Error	The pseudowire **Far End Type** parameter must match the framing mode of the internal DS1 port supporting the pseudowire: • Framed mode: select **E1**, **T1 ESF,** or **T1 SF** • Unframed mode: select **UNFRAMED**
2111	INTERNAL DS1 OF PW IS DOWN	Error	The internal DS1 port assigned to a pseudowire is configured as **Down**. Change its administrative status to **Up**
2112	PW ASSIGNMENT MISMATCH	Warning	When a pseudowire is created, it is necessary to assign it timeslots on a specific internal DS1 port. This message is generated only after the specified pseudowire is created. You can assign the timeslots during the configuration of the pseudowire service parameters; in addition, connect the same timeslots of the internal DS1 port to the prescribed I/O or PDH port
2113	TOO MANY ROUTER INTERFACES	Error	You are trying to configure more than 6 router interfaces on a MPW-1 module (MPW-1 supports a maximum of 6 router interfaces). Check and remove unused interfaces

Code	Syntax	Type	Meaning
2114	NUM OF BYTES IN FRAME EXCEEDS 1440	Error	When using the CESoPSN protocol, the maximum number of bytes per packet exceeds the maximum allowed, 1440 bytes. The number of bytes is determined by the **Payload Size (Frames in Packet)** parameter, multiplied by the number of timeslots assigned to the corresponding pseudowire
2115	CHANGE MAY CAUSE DATA INTERFERENCE	Warning	As a result of the last configuration actions, during the database update you are initiating the internal MPW-1 pseudowire processing assignments will be recalculated. You are warned that this may this cause a short traffic disruption (errors) for the other pseudowires served by the same MPW-1. If this is not acceptable, postpone the update and perform it while traffic load is light
2116	WRONG TIMESLOT ASSIGNMENT	Error	When the redundancy partner of an internal DS1 port of the MPW-1 is a T1 port, it is not allowed to assign more than 24 timeslots on the internal DS1 port
2117	WRONG SATOP PARAMETERS	Error	When using the SAToP protocol, make sure to configure the following parameters as explained below: • **Cross-connect mode** of internal DS1 port: **DS1.** Therefore, only a single pseudowire can be defined on this internal DS1 port. • **Far End Type**: **UNFRAMED**.
2118	PWS FROM DIFF SLOTS DEMAND DIFF PEERS	Error	Pseudowires configured on different MPW-1 modules must be configured with different peers, even if the destination address is the same (see also sanity error 2128). Using different peer numbers will result in the creation of different internal flows, each directed to the relevant router interface
2119	REDUNDANCY PARAMETERS ASSYMETRIC	Error	When redundancy is configured between two internal DS1 ports, all their physical layer parameters must be identical (including the **Signaling Mode**)
2120	PEER DOESN'T EXIST	Error	You have specified a peer index during the creation of a pseudowire, but the peer has not yet been created
2121	PEER NEEDS ROUTER INTERFACE	Error	It is not possible to configure peers before at least one router interface has been configured
2122	PW ASSIGNENT IS DUPLICATED	Error	The same timeslot(s) of an internal DS1 port have been assigned to more than one pseudowire (this may happen because you can assign timeslots either during the configuration of the pseudowire service parameters, or assign them using the internal DS1 port timeslot assignment configuration screen). Check and correct the timeslot assignment

Code	Syntax	Type	Meaning
2123	V1/V2 PW LABEL DUPLICATED	Error	After assigning a label to a pseudowire using payload format **V1**, do not assign the next label in sequence to a pseudowire using payload format **V2** (skip that label). See details given for sanity error 2103
2124	PEER NOT ATTACHED TO PW	Error	User has created a peer without attaching it to any pseudowire
2125	SLOT/PORT OF R.IFACE IS NOT CONNECTED	Error	You must specify a valid I/O slot and port number to the specified router interface
2126	WRONG FAR END TYPE ASSIGNED TO RDN CH	Error	When redundancy is configured between two internal DS1 ports, all their physical layer parameters must be identical (including the **Far End Type**)
2127	PW FAR END TYPE PER SLOT IS NOT EQUAL	Error	When signaling is enabled on the internal DS1 port attached to a pseudowire, the **Far End Type** for all the pseudowires terminated on the corresponding MPW-1 must a framed mode (either E1 or T1)
2128	PEER PARAMETERS ARE DUPLICATED	Error	Different peers must not have the same destination IP address **and** the same Next Hop IP address (at least one of these parameters must be different). Therefore, if it necessary for several pseudowires to reach the same IP address, create separate router interfaces. See also sanity error 2118
2129	CAN'T CARRY MIXED ETH & PW TRAFFIC	Error	An Ethernet port on an I/O module cannot be a member of a flow that carries Ethernet traffic and at the same time, be a member of another flow that carries pseudowire traffic
2130	TS NOT ASSIGNED TO ANY PW	Warning	The specified MPW-1 internal DS1 port is connected to local module ports, but no pseudowire has been assigned timeslots on the same port (the reverse situation is detected by sanity error 2122). You must specify timeslots to be connected to the internal DS1 port
2131	PW CREATED BUT NOT ASSIGNED	Error	A pseudowire has been created, but the attachment circuit was not assigned timeslots
2132	PW CAN'T SERVE AS RECOVERED CLK	Error	A pseudowire using the HDLCoPSN protocol cannot serve as recovered clock source

4.3 Handling Alarms

Table 4-9 lists the specific alarm messages that may generated by Megaplex-4100 for MPW-1 modules, and explains their interpretation. The messages are listed in ascending order of their codes. For other alarm messages, refer to the *Megaplex-4100 Installation and Operation Manual*.

Table 4-9. MPW-1 Specific Alarms

Code	Message	Type	Default Severity	Interpretation
028	HARDWARE/SOFTWARE MISMATCH	SL:CH	Major	It is not allowed to configure the clock quality of the recovered clock to Stratum 1 or Stratum 2 for your MPW-1 version. Contact RAD Marketing Department for details
1201	PW OAM OUT OF SYNC	PW	Major	The OAM signaling mechanism (used to check connectivity) detected loss of connectivity
1202	PW OAM CONFIGURATION MISMATCH	PW	Major	Packet discarded due to mismatch in TDMoIP frame format between the received packet and the pseudowire configuration
1204	PW HW LACK OF TX BUFFERS	PW	Major	Packet discarded due to mismatch between received packet length and pseudowire configuration
1205	PW LOCAL FAIL	PW	Major	Ethernet frames are not received by the local pseudowire on the specified connection
1206	PW LINK FAIL IN REMOTE UNIT	PW	Major	The remote unit reports the reception of a packet with Local Fail indication (L-bit set)
1207	PW REMOTE FAIL (RDI)	PW	Major	The remote unit reports the reception of a packet with Remote Fail indication (R-bit set).
1209	PW RX FRAME LENGTH MISMATCH	PW	Major	Packet discarded due to mismatch between received Ethernet packet length and pseudowire configuration
1210	PW SEQUENCE ERR INSIDE WINDOW	PW	Event	TDMoIP/MPLS packet sequence number error found within the window
1212	PW SEQUENCE ERR OUTSIDE WINDOW	PW	Event	TDMoIP/MPLS packet sequence number error found outside the tracking window
1214	PW JITTER BUFFER UNDERRUN	PW	Event	Underrun has occurred in the jitter buffer of the corresponding pseudowire
1216	PW JITTER BUFFER OVERRUN	PW	Event	Overrun has occurred in the jitter buffer of the corresponding pseudowire
1220	PW RX TDMOIP VERSION MISMATCH	PW	Major	Mismatch between local and remote pseudowire TDMoIP versions
1323	RX MISS ORDERED FRAMES DISCARDED	PW	Event	Packets discarded due to missordering
2029	SFP NOT EXIST	SL:CH	Major	The SFP is not Installed in its socket (this alarm will not appear when the user disables the corresponding LAN port)
2060	LAN NOT CONNECTED	SL:CH	Major	The LAN interface of the MPW-1 is not connected to an active Ethernet LAN (this alarm will not appear when the user disables the corresponding LAN port)

4.4 Troubleshooting

In case a problem occurs with one of the pseudowires carried by the MPW-1 module, check the displayed alarm messages and refer to *Section 4.3* and to the *Megaplex-4100 Installation and Operation Manual* for their interpretation.

Note *If the problem is detected the first time the module is put into operation, perform the following preliminary checks before proceeding:*

- *Check for proper module installation and correct cable connections, in accordance with the system installation plan.*
- *Check the module configuration parameters in accordance with the specific application requirements, as provided by the system administrator.*
- *If the Megaplex-4100 nodal clock is to be locked to the clock recovered from one of the pseudowires carried by the MPW-1 module, make sure a suitable fallback clock source is configured and provides a good clock signal.*

After collecting all the relevant information, perform the actions listed below until the problem is corrected:

- Make sure that no test has been activated on the corresponding MPW-1 internal DS1 port. Use the Megaplex-4100 management system to find the active test or loopback, and deactivate it.
- Activate the local loopback on the corresponding port timeslots that carry the corresponding pseudowire. While the loop is connected, the user's equipment served by pseudowires configured on the corresponding port should receive its own signal; if not, the problem is external. Check cable connections, and any transmission equipment providing the link to the user's equipment.
- You can rapidly check the link to the remote unit by activating, at the remote unit, the remote loopback on the corresponding timeslots of the remote internal DS1 port. If the link operates OK, the local user's equipment served by pseudowires configured on the corresponding port should receive its own signal.

  If the test fails, there is a problem with the transmission through the network, or with the MPW-1 modules:

  - Using the **ping** test to check IP connectivity to the destination IP address of the relevant pseudowires. If ping fails, the problem is in the network
  - Repeat the test after carefully checking all the configuration parameters of the module and its ports. If the problem persists, replace the module and check again.

4.5 Diagnostic Functions

The MPW-1 modules support the following diagnostic function:

- Loopbacks on selected timeslots of the internal DS1 ports:
  - Local loopback per timeslot
  - Remote loopback per timeslot
- Ping test, which enables checking the IP connectivity between MPW-1 packet ports and the pseudowire destination IP address.

The following sections explain the loopbacks and tests supported by MPW-1 modules.

Note that the activation of a loopback disconnects the local and remote equipment served by the corresponding pseudowire. Therefore, when you initiate a loopback, you have the option to limit its duration to a selectable interval in the range of 1 through 30 minutes. After the selected interval expires, the loopback is automatically deactivated, without operator intervention. However, you can always deactivate a loopback activated on the local Megaplex-4100 before this time-out expires.

Local Loopback on Selected Internal DS1 Port Timeslots

The local loopback on timeslots of an MPW-1 internal DS1 port is used to return the transmit payload carried by selected timeslots of the tested port through the same timeslots of the receive path. The timeslots looped back remain connected to the transmit path of the port, but the corresponding timeslots received from the remote end are disconnected.

This test is recommended for testing signal paths between the I/O port of the other local module which uses the pseudowire, and the MPW-1 port.

The loopback is activated within the MPW-1 pseudowire cross-connect matrix, and only on the timeslots specified by the user during the activation of the loopback. As a result, there is no disturbance to services provided by means of the other timeslots (pseudowires) of the same port: only the flow of payload carried by the specified timeslots is disrupted.

The signal paths for a local loopback on timeslots are shown in *Figure 4-1*.

The user can activate the loopback on any individual timeslot, or on several arbitrarily selected timeslots.

When the loopback is activated on timeslots of a port which is part of a redundancy pair, the CL module automatically activates the loopback on the same timeslots of the other port of the pair. The same is true for timeslots assigned to the same pseudowire.

This convenience feature is also available for loopback deactivation: the deactivation command can be issued to either one of the ports of the redundancy pair (even if it has been activated by a command to the other port).

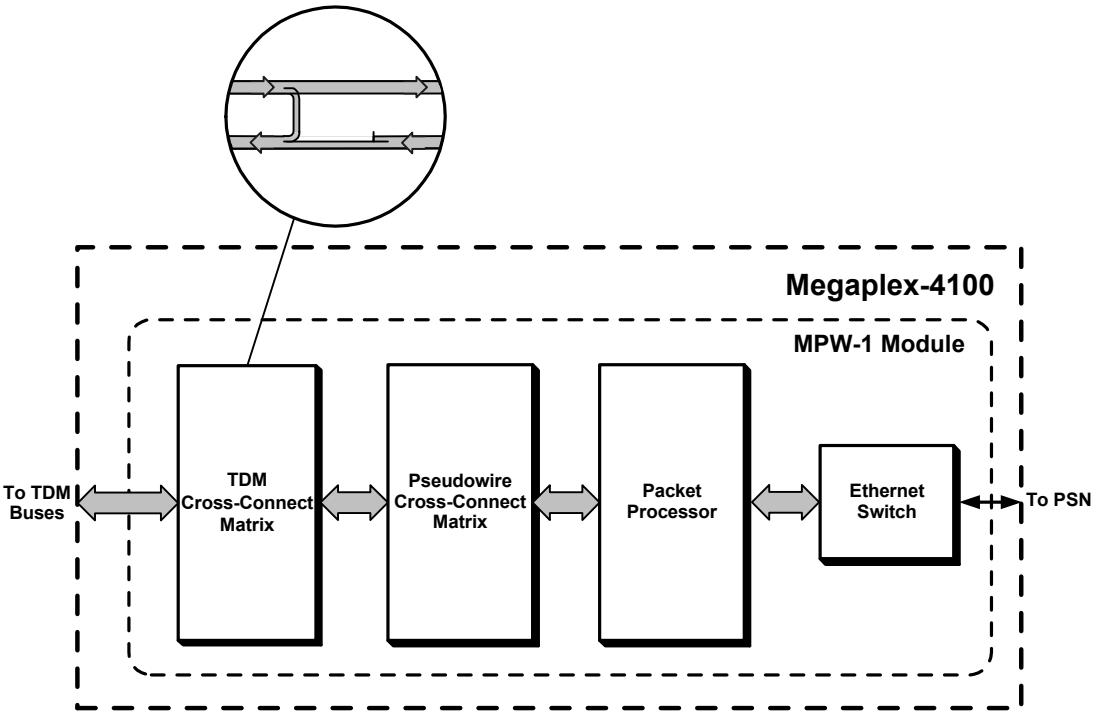


Figure 4-1. Local Loopback on Selected Internal DS1 Port Timeslots, Signal Paths

For the supervision terminal, use the following procedure to activate/deactivate a local loopback on a selected timeslot (for detailed instructions, refer to the *Megaplex-4100 Installation and Operation Manual*):

1. Open the **Diagnostics › Physical Layer › I/O** menu, and then select the I/O slot of the desired MPW-1 module. The selection screen displays only modules installed in the Megaplex-4100.
2. On the module **Diagnostics › Physical Layer › I/O › Port** screen, select the MPW-1 port to be tested, in the range of **Int DS1 1** to **Int DS1 8**. Only connected ports can be tested.
3. If necessary, select the loopback duration on the **Diagnostics › Physical Layer › I/O › Time Out** screen. The loopback will be automatically deactivated after the specified interval.
4. To activate (start) a loopback on a selected timeslot, select **Loop Per Timeslot** on the **Diagnostics › Physical Layer › I/O › Test Type** screen, and then press **‹Enter›**.
5. You will see now the timeslot test selection screen. The screen includes the list of timeslots of the selected port (link), presents information on the destination of each timeslot and the traffic type, and in addition includes a test selection field: when this field is selected, you have the option to activate a **Local Loop**.
6. At this stage, type **T** to activate the test.
7. To manually deactivate (stop) the loopback, select **None** for the timeslot, and then type **T** to deactivate the test.

Remote Loopback on Selected Internal DS1 Port Timeslots

The signal paths for a remote loopback on timeslots are shown in *Figure 4-2*.

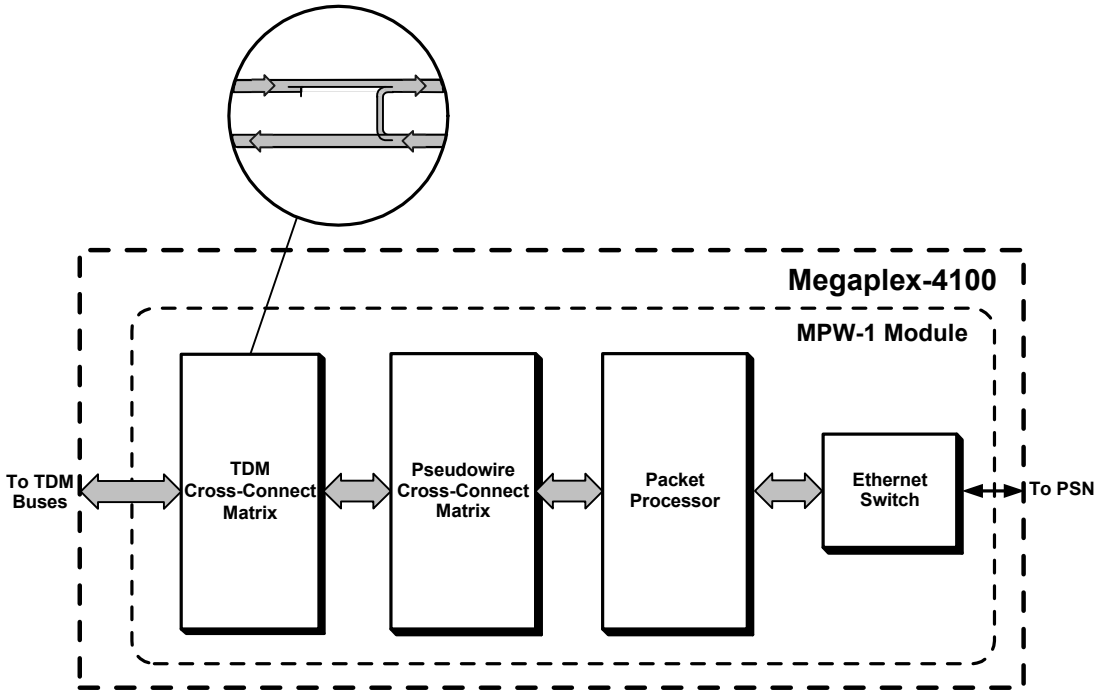


Figure 4-2. Remote Loopback on Selected Internal DS1 Port Timeslots, Signal Paths

The remote loopback on timeslots of an MPW-1 port is used to return the receive payload carried by selected timeslots of the tested port through the same timeslots of the transmit path. The corresponding timeslots received from the local equipment are disconnected.

This test is recommended for testing signal paths from a remote equipment unit, through a selected pseudowire served by the corresponding MPW-1 port.

The loopback is activated within the MPW-1 cross-connect matrix, and only on the timeslots specified by the user during the activation of the loopback. As a result, there is no disturbance to services provided by means of the other timeslots (pseudowires) of the same port: only the flow of payload carried by the specified timeslots is disrupted.

For the supervision terminal, use the following procedure to activate/deactivate a remote loopback on a selected timeslot (for detailed instructions, refer to the *Megaplex-4100 Installation and Operation Manual*):

1. Open the **Diagnostics › Physical Layer › I/O** menu, and then select the I/O slot of the desired MPW-1 module. The selection screen displays only modules installed in the Megaplex-4100.
2. On the module **Diagnostics › Physical Layer › I/O › Port** screen, select the MPW-1 port to be tested, in the range of **Int DS1 1** to **Int DS1 8**. Only connected ports can be tested.
3. If necessary, select the loopback duration on the **Diagnostics › Physical Layer › I/O › Time Out** screen. The loopback will be automatically deactivated after the specified interval.

4. To activate (start) a loopback on a selected timeslot, select **Loop Per Timeslot** on the **Diagnostics › Physical Layer › I/O › Test Type** screen, and then press **‹Enter›**.
5. You will see now the timeslot test selection screen. The screen includes the list of timeslots of the selected port (link), presents information on the destination of each timeslot and the traffic type, and in addition includes a test selection field: when this field is selected, you have the option to activate a **Remote Loop**.
6. At this stage, type **T** to activate the test.
7. To deactivate (stop) the loopback, select **None** for the timeslot, and then type **T** to deactivate the test.

The other features related to loopback activation/deactivation described above for the local loopback on timeslots are also applicable to the remote loopback.

Ping Test

MPW-1 modules installed in Megaplex-4100 can use the **ping** function, to check IP connectivity between a MPW-1 packet port and the desired destination IP address (that is, to a pseudowire peer). The user can select the destination IP address and configure the number of ping packets sent. The port used to send the ping packets is automatically selected, in accordance with the following criteria:

1. If the destination IP address is within the host IP subnet of the CL module, the ping packets are sent by the CL module, and therefore use its IP address as the source address.
2. If the destination IP address is not within the CL module subnet, but is within the subnet of one of the router interfaces, the ping packets are sent by the MPW-1 module associated with that router interface.
3. If the destination IP address is neither within the CL module subnet, nor within a router interface, the ping packets are sent by the CL module using the configured default gateway.

For the supervision terminal, use the following procedure to send pings to a selected peer (for detailed instructions, refer to the *Megaplex-4100 Installation and Operation Manual*):

1. Open the **Diagnostics** menu, and then select **Ping Test**.
2. On the **Ping Test** screen, select the following parameters:
   - The desired destination IP address
   - The number of ping packets (up to 50) to be sent. Pinging will be automatically stopped after sending the specified number of ping packets.
3. To start ping sending, select **Send Ping**, and then press **‹Enter›**.
4. The prompt area at the bottom of the screen starts displaying the results of each ping packet. After the selected number of packets, you will see the test summary, which indicates the number of packets sent and received, and the number of lost packets (packets not answered before the standard time-out interval expires).

4.6 Technical Support

Technical support for this product can be obtained from the local distributor from whom it was purchased.

For further information, please contact the RAD distributor nearest you or one of RAD's offices worldwide. This information can be found at www.rad.com (offices – About RAD > Worldwide Offices; distributors – Where to Buy > End Users).

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Publication No. 464-202-12/08

Order this publication by Catalog No. 803835

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